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UNDERGROUND CONDUCTORS.

THE subject of underground conductors for the electric current is daily assuming a more important character. Already in New York a decree has been made that all wires are to go underground, and in another part of the present issue we publish a description of the Dorsett system of subway conduit which the New York Electrical Subway Commission has accepted as the most suitable for the purpose of carrying the wires beneath the surface of the streets.

Without anticipating the adoption of any such sweeping measure for the suppression of overhead wires in this country, we cannot close our eyes to the fact that, in view of the rapid multiplication of such wires, some means must eventually be taken for preventing them from becoming so numerous as to constitute a nuisance and a probable source of danger and make supervision, and even proper working, extremely difficult. Therefore any system which is brought forward with the view of lessening the disadvantages of underground conduction will inevitably receive adequate consideration. In addition to the Dorsett system, we this week also describe the invention of Mr. Callender and Major-General Webber, for distributing the electric current by means of underground conductors. Mr. Callender is well known in this country and in America in connection with his bitumen-covered cables, and his vast experience upon similar subjects induced the New York Commission to invite from him a communication advising them as to the points to be sought and avoided in carrying electrical wires underground.

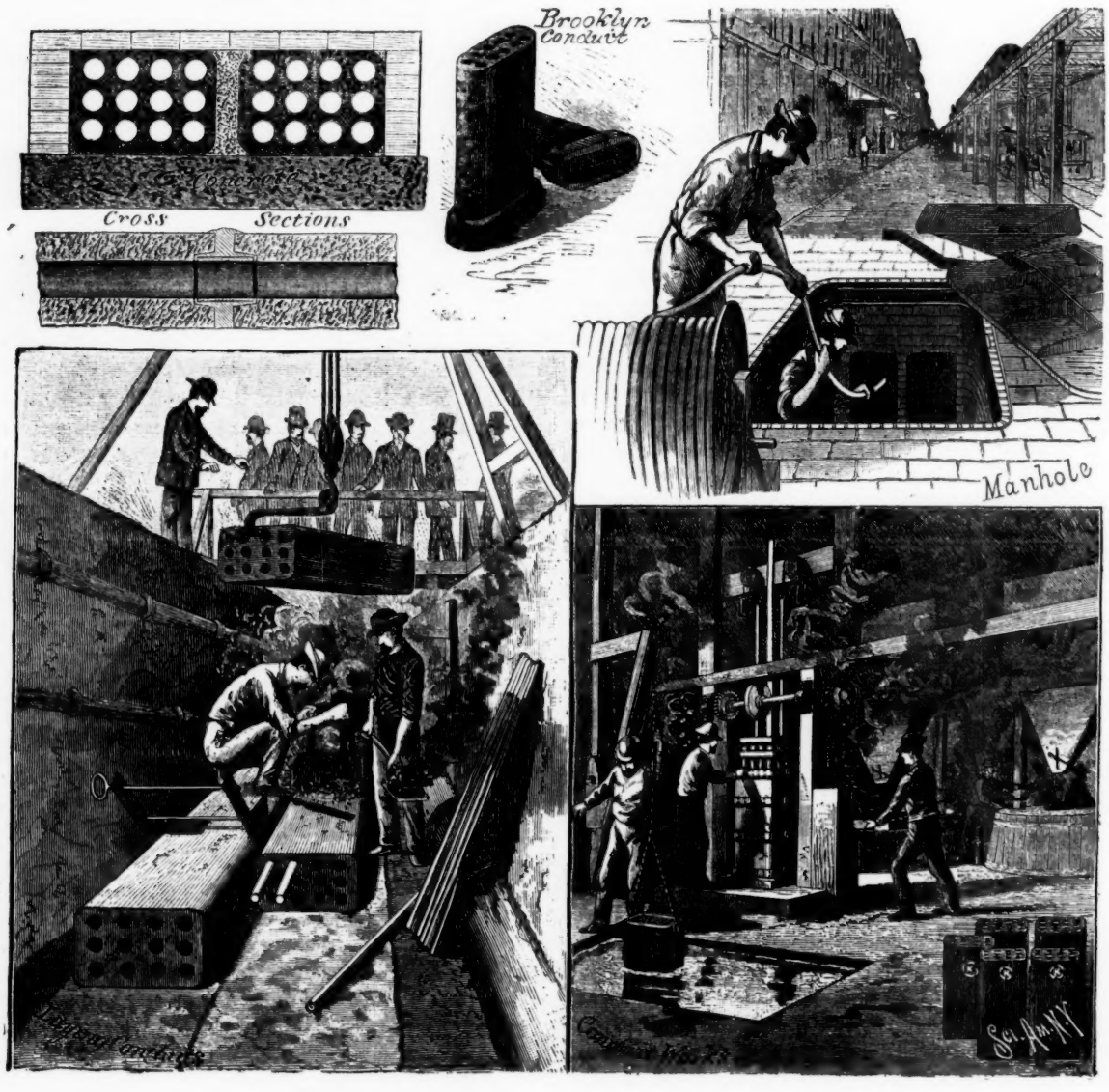
In that communication, which is before us, Mr. Callender gives a valuable amount of information which it is a great pity the Commission has not acted upon. The Commission has decided that the material to be used in the formation of the conduits shall be "an asphalt or bituminous concrete." Such a concrete may be manufactured by the use as a binding material of either natural asphalte or bitumen, or the refuse pitch produced by the distillation of coal tar.

The natural asphalt or bitumen has been used from time immemorial for all kinds of engineering works, and with unfailing success. This success attracted about twenty years ago a great deal of attention, and experiments were made with coal tar pitch, which appeared in some respects to be of a similar character. When, in 1870-73, it was known that the genuine asphalt pavements had been so successfully laid in Europe, chemists in this country and abroad proved to their own entire satisfaction that coal tar pitch concrete was almost exactly the same thing, and would make an equally good and durable pavement, Outside people believed these expert theorists and provided a large amount of capital all over the world, so that what was known as "asphalt pavements" became the rage and millions of square yards were laid under this name with a material which contained no particle of asphalt. Within a very short time disintegration commenced, and before many years elapsed the whole of the work had gone to pieces. The absolute failure of all attempts to make good concrete from coal tar pitch incensed the public, who did not understand the difference between this spurious material and real asphalt, and the industry received a blow from which it has barely recovered after the lapse of fifteen years. Experience here and in other countries has shown these two facts to be indisputable: first, that so-called asphalt consisting of coal tar pitch, although it may serve the required purposes for some time, in the course of a year or so invariably breaks down and becomes useless; and in the second place, that where the genuine asphalt has been used—and it has been used for a variety of purposes—it has been eminently successful and has stood the test of years. Seeing that these facts have been so amply demonstrated—Mr. Callender cites a number of pertinent instances in his letter to the New York Subway Commission—it is not a little remarkable that the contract for the tremendous undertaking which is to be carried out underneath the New York streets should be given to a corporation which uses nothing but coal tar pitch for its conduits. It should be recollected that this is intended to be a permanent work, and not one which may be replaced in five, ten or twenty years' time. The main argument for this radical measure has been that it will once for all dispose of a vexed question, satisfying those who complain of the danger and unsightliness of overhead wires, and appeasing the proprietors of electrical conductors by providing them with a practicable, safe and easily supervised means of distributing their currents. What becomes of the force of this argument if the assertion of Dr. Chisholm, President of the Thomson-Houston Illuminating Company of Chicago, be true? He says: "The material is of a nature permeable by gases and afterwards by water . . . . They claim that it is an insulating material, but after a comparatively short time it is not." The employment of this composition seems to be a grave error, and it is greatly to be hoped that the members of the Commission will come to their senses before the mischief they seem bent upon effecting becomes irreparable.

Glass Decoration.—A new process for the decoration of glass by gold or silver is being introduced by the Glass Decoration Company, of which Mr. George Matthey, F.R.S., is chairman. The gold or silver is deposited in solution on the underside of the glass, and protected by a composition that is impervious to the atmosphere; it is thus effectually preserved against all external damage, and from the destructive effects of oxidation. It is stated that this is a re-discovery of a lost art, and that the cost of decorating glass in this way is no greater than that of the ordinary style of gold leaf decoration on the surface.

THE ELECTRIC SUBWAY CONDUIT IN NEW YORK.

NEARLY a year and a-half have passed, says the *Scientific American*, since the subway commissioners were appointed, under a special act of the Legislature, to supervise the burying of the telegraph lines in this city. To do this work intelligently, a special study of the subject was required, together with a comparison of the different methods proposed by inventors. As the telegraph companies had done nothing to further the objects of the commission, a subway company was formed. This company, receiving its franchise from the commissioners, is now engaged in laying the conduit.

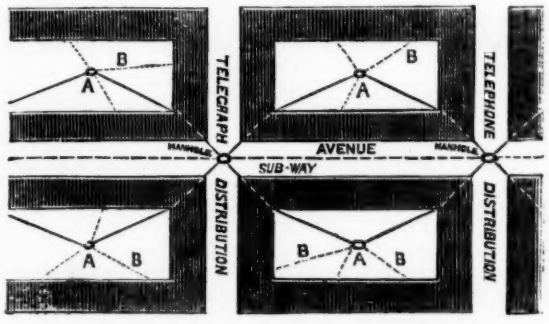


The material of which it is composed is a mixture of three or four parts of coal-tar pitch to one of sand. This is moulded into prismoidal blocks, three feet long, each block containing twelve longitudinal apertures, 2½ inches in diameter. Each of these apertures can accommodate a cable containing 100 telephone wires. Their manufacture is thus conducted: Sand is received at the factory and screened carefully. As fast as screened it is introduced into a long inclined cylinder, through which the products of combustion from a furnace pass on their way to the chimney. This cylinder, about 18 inches in diameter and 14 feet long, contains projecting pieces running lengthwise along its inner surface. These pieces are 4 inches wide and 18 inches long, and, as the cylinder revolves, pick up and drop the sand, which emerges at its lower end quite hot and perfectly dry. Thence, by a chain and hopper elevator, it is carried up to a second floor, where it is placed in receptacles provided with steam coils, by which it is again heated. It is fed as fast as needed through spouts into mixing tanks on the lower floor. Melted pitch is fed in the same general way into the same vats, and the mixture is thoroughly stirred by rotary blades within them. The peculiarity of the process up to this point consists in the use of hot sand. About 30 per cent. is present in the completed mixture. The blocks are formed in moulds from the hot material by ramming.

In addition to top and bottom plates, each mould consists of two parts, which are secured by lugs. When these two parts are joined, they form an open-ended prismoid. This is set up on end within the ramming apparatus, as shown in the cut. Twelve iron mandrels have first been projected upward from the base through the bottom plate, and are well oiled by swabs applied by hand. The mixture is introduced by boxes of the same outline as the blocks, and provided with removable bottoms. The filled box is placed over the open end, and its bottom withdrawn, its contents falling into

the mould. After six or eight inches have been filled, the rammer is set to work, and a rapid succession of blows produced, until the sound shows that the mass is compact. Then more mixture is introduced, and more ramming given it, until the mould is filled. Owing to the ramming, it is very hard and compact. The mould and block, after being cooled by the application of water from a hose, is swung away and cooled completely in a tank of water, the outer casing is removed, and a finished block is the result. They are inspected by the commissioners' inspector, and, if approved, are stencilled.

Besides the blocks, short paper tubes, that fit into enlargements in the ends of the apertures, are supplied. They are used to complete the conduit at the joints. They are dipped into melted pitch before delivery. Their use is shown most distinctly in the longitudinal section of the conduit, where the enlarged ends of the holes can also be seen.



A, Central Distributing Point. B, Distributing Lines.

PLAN OF DISTRIBUTION.

The conduit is laid in sections, every one of which is one block in length. Each section must be rigorously aligned, both as regards the vertical and horizontal planes. The grade must be perfectly uniform and true for this distance. It may vary from block to block, as may also the level. A trench is opened, and on its bottom a 6 inch bed of concrete is laid. This is made to conform accurately to the level or grade of the section, and by theodolite a straight line is drawn along its centre. After it is sufficiently hard, the blocks are laid upon it in two longitudinal rows, breaking joints with each other. They are kept accurately in line, and are spaced apart by a template. Each block is laid thus: It is lowered into the trench, and placed in position about one inch from the preceding one. A hot plate of iron is held between the end faces of the two blocks until the ends are thoroughly hot. The paper tubes are next put into their seats, and long wooden mandrels are pushed through them and into the next block from the open end of the block that is being laid. The two segments are then pushed together until the paper tubes are seated. This brings them within an inch of each other, which interval is spanned by the twelve tubes and mandrels within them. Side or cheek pieces of iron are clamped on each side of the joint, and hot asphalte mixture is introduced, and worked in around the interstices by hot iron bars. The mandrels are withdrawn, and when the whole is perfectly filled and smoothed off, it is left to cool, the clamps not being removed for some time. When all is cold, the clamps are removed, and the longitudinal interval between the rows is filled with cement mortar, and a course of brick is laid over and around the two lines. Each block contains twelve holes, in three rows. In some sections the blocks are placed on their narrow edge; in others they are laid flat.

At each cross street is a large bricked manhole, in which one section ends and the next one commences. A double iron cover, one protective and the other arranged to lock fast, secure it when not in use. The cables are to be laid by means of these openings, being fed through by a machine, after they are started. The entire length of the openings, for a block at a time, is previously to be well oiled to reduce friction.

The impediments in the way of the engineers have been very great. Three separate gas companies have a number of mains lying in close proximity to the trench. The water mains and sewer culverts also impede operation greatly.

This much refers to the New York system. In Brooklyn the same material is employed, but the blocks have ten apertures only, of less diameter than in the New York conduit, and each block is provided with a bell or hub. These are laid like water or gas pipes, the paper tubes being dispensed with.

This much disposes of the question of the disposal of transit lines. The next problem is that of distribution to different houses and offices. The proposed method is shown in the accompanying plan. Each second manhole is to be devoted to the distribution of telephone lines, and the alternate ones to telegraph line connections. A main branch is to be carried from the manhole to the interior of each block of houses. As near the centre as may be is to be established either a single pole or a manhole. From this point individual lines are to be carried under or over ground to the different houses requiring them.

Such is the system now being introduced. Its principal characteristics is the absence of metal. Even the short joint tubes are of paper. While cheapness of construction is thus consulted, many good effects of metal are lost. The interior of the holes can hardly be as smooth as a good metallic pipe, and they will be more subject to deformation. A slow change of shape, such as sealing wax often will undergo, is among the possibilities. This, it is assumed, will be prevented by the large proportion of sand that is worked into the mixture. The anti-inductive effect of metal is lost. This will be provided for in each individual cable, it is to be presumed, in its lead casing. The objection made to metal pipes that they will decay cannot be regarded as well founded. A good cast iron pipe will last for a number of years as yet undetermined.

A COMPARISON BETWEEN THE DIFFERENT SYSTEMS OF TRANSMITTING MOTIVE POWER.

By JULES LAURIOL.

THE chief agents for the transmission of motive power to a distance, as now in use, are: electricity, water under pressure, compressed air, and tele-dynamic cables.

In the outset we must remember that the cost price of a unit of work at a given place depends: (1), on the cost of power supplied by the mechanical motor; (2), on the useful effect or the yield of the system of transference; and (3), on the first cost and the maintenance of the installation.

The first of these items varies greatly, according to the origin of the motive power (steam, water, or gas), the size of the machinery, the number of working hours, the price of labour, &c. According to Prof. Grove, of Hanover, the hourly cost per horse-power if supplied by a steam engine varies from 0·450 to 0·120 franc; if by water, 0·020; and if by a gas engine it is 0·450.

Electric transmission, though the most recent system, shows already such advantages as to warrant us in entertaining the boldest hopes.

An electric transmission of motive power comprises a dynamo machine known as the generator, which transforms the mechanical work to be transmitted into electricity; a cable conducting the current produced to a second dynamo called the recipient, which re-converts the electric energy it receives into mechanical energy. Hence the yield of the system is composed of three parts: the yield of the generator,

the yield of the conducting wire, and the yield of the recipient, and is the product of these three parts. We must further distinguish in the total useful effect the electric yield expressed by the ratio of the counter electromotive force developed by the recipient to the electromotive force produced by the generator, and the mechanical yield which is the ratio of the useful work collected on the pulley of the recipient to the motive power expended on the pulley of the generator.

If we suppose an ideal transformation of the forces, that is a complete conversion of motor work into electric energy, and, reciprocally, the mechanical yield becomes equal to the electric yield, and we have :

$$E'_u = 1 - 0012\ L.$$

In this expression E'_u denotes the useful effect, and L the length of the transmission. But such an ideal transformation can never take place. According to the most recent experiments we may admit that 85 per cent. of the mechanical work supplied to the generator is converted into an electric current, whilst the recipient re-converts into mechanical work 75 per cent. of the electric energy which it receives. These losses are due to causes perfectly well-known to electricians. We must therefore multiply the electric yield by the product of the two coefficients just indicated ($0{\cdot}85 \times 0{\cdot}75 = 0{\cdot}64$) to obtain the ultimate mechanical yield : $E_u = E'_u \times 0{\cdot}64 = (1 - 0{\cdot}0012\ L)\ 0{\cdot}64$. For a transfer of 100 metres, $E_u = 0{\cdot}649$; for 1,000 metres, 0·642 ; for 10,000, 0·570 ; and for 20,000, 0·500. This last distance will rarely be exceeded in practice.

For transmitting five horse-power the expenses of the installation, including the two dynamos, the cost of fixing them, and the conducting line, will be for 100 metres 8,375 francs.

If we base our calculations upon the yield as given above, and allow 16 per cent. for interest on capital, paying off first cost, we obtain the figures given below for the hourly cost per horse-power, supposing the motive power to be originally furnished either by a large steam engine of improved construction or by a hydraulic machine.

One hundred horse-power, if supplied by a steam engine, may be transmitted 20,000 metres for 0·480 franc hourly per horse-power, but for 0·120 franc if the original motive power is water.

Transmission by Water under Pressure.

This kind of transmission has the advantage that the power consumed at each point of the distribution can be very exactly measured by the volume of water passed into the motor of the subscriber. No other method of transmission possesses this advantage in an equal degree. The conducting pipes for water under pressure are relatively costly, but compressed air presents in this respect no advantage, as there are the same expenses for taking up and re-laying the public roads. The electric system presents in this respect an especial advantage, since an electric conductor for the transmission of an equal amount of power is much less bulky than a main of compressed air or of water under pressure.

The water system has, therefore, no marked advantages ; if introduced into houses it certainly allows of combating the first outbreak of a fire, but the leakage from the joints of the pipes is often annoying. If the quantity of power to be transmitted is at all important mains of a large diameter are necessary, and the hydraulic motor cannot be removed, if this is desirable without costly work. It is much less portable than the electric motor. There is also the risk that in a severe winter frost may burst the mains, or may at least stop the working of the system.

A transmission of this kind is composed of :—1. A forcing pump to raise the water, if this is not at a sufficient level to give the requisite pressure. 2. The main and the accumulator. 3. The hydraulic motor, which may be a turbine. The yield of power in the forcing pumps may be taken at the mean as 85 per cent. The useful effect in the pipes for pressures not exceeding 25 atmospheres ranges from 0·98 for 100 metres in length to 0·40 per cent. for 20,000 metres. The yield of the hydraulic motors employed most generally is from 0·60 to 0·70. From these three useful effects the total yield may be found as below, taking as before 16 per cent. for interest, &c., and assuming that the initial motive power is furnished either by a large steam engine or by a hydraulic motor. The hourly cost per horse-power for the transmission of 100 horse-power to the distance of 20,000 metres is 0·997 franc, if the power is obtained from a steam engine, and 0·369 if it is derived from a hydraulic machine.

Transmission by Compressed Air.

Air-compressors, established where the motive force is to be produced, compress the air, which a system of pipes then distributes among the various consumers.

Compressed air may be employed with advantage in tunnels, and wherever the yield of motive power plays a secondary part. But if power has to be distributed to numerous establishments the useful effect is reduced to a maximum of 50 per cent.

Transmission of compressed air presents, therefore, as much inconvenience as water under pressure. Its application seems useful, at most, in perforating tunnels and the galleries of mines. Even there the electric system has the advantage of being more easy to establish. It is far easier to place, and especially to extend an electric conductor, than a pipe conveying compressed air, especially where it is required to traverse low narrow galleries, and to convey the motive force to perforating machines.

On the other hand, perforators worked by air often suffice for ventilation, whilst the electric system presupposes special ventilating arrangement. Yet such is the advantage of electricity in economy and simplicity, that the electric system is preferable wherever there is no fear of the sparks from the dynamos igniting explosive gases. Electricity can serve at the same time for lighting, whilst compressed air necessitates the employment of separate lights, which help to vitiate the air of the tunnel or the gallery.

For the useful effect of the air compressors we take the coefficient 0·75 (a figure which has not been exceeded at the Gothard) ; as for the yield of the air motors, we may take 0·60 as the mean for good permanent plant. The loss in the mains is slight, E'_u ranging from 0·998 for 100 metres to 0·700 for 20,000 metres. Hence we find in round numbers $E_u = 0{\cdot}45$ for the former distance and 0·35 for the latter. The yields are much smaller for boring machines. The hourly cost, therefore, per horse-power of conveying 100 horse-power to the distance of 20,000 metres is 0·666 franc, if the initial motor is a steam engine ; and 0·350 if it is water-power.

Transmission by Tele-dynamic Cables.

This system, invented in 1850 by Hirn, and analogous to transmission by driving bands, is the simplest of all. The cable rests upon two pulleys, so that the tension is due simply to the weight of the cable. If the distance is too long additional pulleys are placed at every 100 metres by way of supports. Notwithstanding its simplicity this system is being generally abandoned. The expense of maintaining the cables is considerable. They require to be renewed annually, and when new they stretch and require to be frequently shortened. Sometimes they break, which occasions much danger when they pass over streets, especially as they are generally moving at a high speed. They are best adapted for the transmission of motive power in country places, but they cannot be employed for the sub-division of power.

The losses are those due to friction, to the resistance of the air, to the slipping of the cable on the pulleys, and to its rigidity. The yield for distances not exceeding one kilometre is 90 per cent. Beyond this limit it falls very rapidly as compared with the other systems, so that for five kilometres it has no advantage. The hourly cost per horse-power of transmitting 100 horse-power to a distance of 20 kilometres is to 321

francs or 0·353, according as the initial power is supplied by a steam engine or by water.

Transmission by Coal Gas.

The use of gas engines has been extended in consequence of the easy installation of these machines, and the facility of setting them in action. They require no special superintendence, and the consumption of gas ceases as soon as the engine is at rest. The power supplied, however, is costly; there is also required a supply of cold water to effect the refrigeration of the cylinder, and there is much more danger than in any other system.

Transmission by Steam and by Rarified Air.

The former of these systems has been tried at New York, but it has been abandoned in consequence of the serious difficulties occasioned by the condensation of the steam. The second system has been attempted at Paris, but its returns are not much higher than those of compressed air.

The figures already given under the first four systems admit of an easy comparison of their respective advantages.

If we assume that the local circumstances are equally favourable to any system, the comparison of the prices shows that electricity or tele-dynamic cables are the most advantageous agents for the transmission of power. Of these two we select the cables as the most economical for short distances (up to one kilometre), and for longer distances electricity. In cases where tele-dynamic cables are inapplicable, the electric transmission is far preferable to transmission by water under pressure or by compressed air.

The subjoined table summarises the cost of the transmission of 100 horse-power by the different systems which we have analysed.

DISTANCE OF TRANSMISSION.

System employed.	100 m.	200	1,000	5,000	10,000	20,000	Initial motor.
Electricity	0·187	0·192	0·202	0·236	0·296	0·480	Steam engine
Water under pressure	0·236	0·246	0·272	0·420	0·603	0·997	
Compressed air	0·330	0·336	0·347	0·442	0·547	0·666	
Teledynamic cable	0·131	0·155	0·165	0·300	0·520	1·321	
Electricity	0·048	0·050	0·055	0·065	0·071	0·120	Hyraulic machine
Water under pressure	0·048	0·057	0·065	0·139	0·232	0 369	
Compressed air	0·075	0·083	0·087	0·126	0·194	0·350	
Teledynamic cable	0·026	0·028	0·031	0 083	0·148	0·353	

We see that the transmissions of power by electricity are much more economical than those of water under pressure or by compressed air, so that if we wish to produce power in a central establishment and distribute it from house to house in a radius of 10—20 kilometres, electricity alone can solve the problem economically. Thus if we divide the region to be supplied with power into blocks of 10—15 kilometres square, having each a large steam engine, one horse-power might be supplied at the hourly cost of 0·30 franc, whilst with a gas engine the hourly cost per horse-power is 0·45 franc. With a hydraulic motor the cost per horse-power is only 0·10 franc, which constitutes an important economy in favour of electricity.

In virtue of the important advantages which it possesses, the electric transmission of motive power is destined to receive a great number of applications; as soon as central establishments for the production of electricity are arranged for effecting the distribution to houses, electric motors cannot fail in many places to supersede steam engines, &c., within a wide circle, especially if we consider that electricity at the distance of 20 kilometres (in round numbers 12 miles) does not cost more than the same power produced on the spot by an improved steam engine of 100—200 horse-power, not consuming more than 1,300 to 1,500 grammes of coal hourly per horse-power. The advantage will be still greater at smaller distances and when it comes to supersede gas engines and small steam engines of 20 horse-power or under which consume as much as 2—3 kilos of fuel hourly per horse-power.

Besides, dynamos have the advantage of simplicity over all the motors now in use. Their only movable part is a shaft turning in a pair of plummer blocks and carrying one or more bobbins of copper wire in perfect equilibrium. The mechanical resistance due to friction is reduced to a minimum, and there are no losses like those due to the condensation of steam, to the bad packing of pistons and valves and to the shocks of the parts in motion. The materials constituting the machine, soft iron and copper, are not exposed to wear by reason of constant work and consequently their depreciation is minimised.

The electric motor has further the following advantages over its rivals:

1. Easy removal, since in order to set it in motion it merely needs to be connected with the general circuit by means of two flexible conductors.
2. Small weight for a given quantity of work.
3. Possibility of acting well at a very great distance from the initial motor.
4. Excellent yield at high speeds; these motors are especially suitable for impelling apparatus which requires to act at great velocities without requiring intermediate transmissions which uselessly absorb a quantity of the power.
5. Absolute neatness and security, since these motors produce neither smoke nor ashes and yield no sort of refuse.

In consequence of the portability of these machines they can often be brought up to the work to be done in place of removing the latter to the source of power.

In order to arrive at the general and ultimate employment of electricity, we must above all things seek to reduce as far as possible the cost of producing the electric current. The methods now in use for obtaining it are inconvenient and costly since we require boilers, engines, and dynamos to transform the carbon of the coal (better, the energy liberated by the oxidation of such carbon) into electricity. Hence there is a notable loss which requires a large quantity of work to render remunerative. But when a great central establishment shall furnish electricity so as to give light, motive power and heat to houses, shops, public establishments, and manufactories, we shall be present at a wonderful revolution. We shall reach this end only by establishing large works for generating electricity on the banks of rivers, so that the dynamos may be driven by hydraulic motors which are much more economical (both in first cost and in maintenance) than the best steam engines. The rivers of France represent a power of 15 or 20 million horse-power which at present runs to waste.

To show the economy of electric appliances we will take for comparison a hydraulic crane of the power of 3,000 kilos (3 metric tons) admitting that the speed of raising the load is $\frac{1}{2}$ metre per second. Here the theoretic work of the crane per unit of time is 3,000 × 0·50 = 1,500 kilogrammetres, and supposing that the apparatus gives a yield of 60 per cent., the effective work at the piston will be 250 kilogrammetres if the pressure of the water is 50 kilos per square centi-

metre, the volume of liquid necessary to execute the above work will be 5 litres, and the diameter and the stroke of the plunger will be arranged accordingly. When such a crane lifts a load of three tons it works normally and its yield is at a maximum. But if the load raised to the same height is only one ton, the same quantity of water will still be expended and the yield will be only 33 per cent. With an electric crane the effective work developed by the recipient motor will always be strictly proportionate to the useful work to be produced, *i.e.*, to the load to be raised. It is the same for other machines, such as those for working the gates of locks and sluices, for working turn-bridges, capstans, &c. The use of electricity as a mechanical power for domestic uses will be certainly as important as for electric lighting. Electric energy may be employed in the household for setting in motion sewing machines, pumping water, working elevators, turning washing machines, &c. The author goes on to show the advantages of electricity in workshops, where it may supersede driving bands, a constant source of danger.

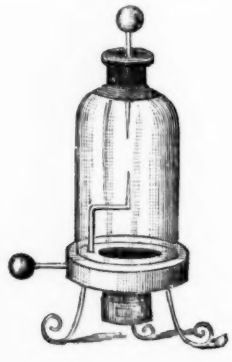
Summing up, M. Lauriot says that the transmissions of motive power by electricity have every claim to be recommended and employed, firstly, because they are of wider scope than transmissions based upon the continuous displacement of any material substance (gas, steam, air, or water) from the place of its production to the place where the energy is to be employed, and then because of its undoubted superiority and convenience in use. The energy is transformed into heat only for such applications as require it, and it is superior even to gas in such cases as require the concentration of a great quantity of air at a given point and for the conversion of heat into light.

Where mechanical work is required the energy passes directly from the electrical to the mechanical state by means of apparatus less costly, less bulky, and easier to manage than the simplest appliances necessary for effecting the same object.

As for distribution, properly so-called, the natural superiority of electricity is at once manifest.—*La Genie Civil.*

ELECTRICAL DEPOSITION OF DUST AND SMOKE.

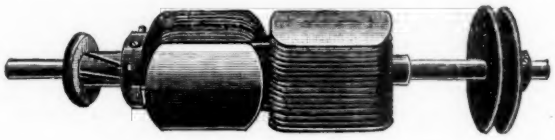
THE remarkable behaviour of dust and smoke when subjected to a strain set up in an intervening dielectric has of late attracted much attention, and we therefore have great pleasure in illustrating a convenient piece of apparatus designed and constructed by Messrs. King,



Mendham & Co., of the Western Electrical Works, Bristol, by means of which the interesting phenomenon of the deposition of dust and smoke may be produced and observed. It consists of a bell jar, through the top of which is fixed a brass rod carrying a brass ball at its upper extremity and terminating in a point within the jar; opposite to this is placed another rod, which passes out through the base of the apparatus. Each of these rods is intended to be placed in metallic connection with an electrode of a Wimshurst electrical machine. The bell jar is mounted on three supports, and beneath the base is a cylindrical box in metal in which the fume can be produced. Smouldering brown paper is placed in this metal box, and when the smoke has completely filled the jar, the machine is started and the smoke, which at first appears to be greatly agitated, is observed to be quietly vanishing, leaving the jar perfectly empty.

THE STOCKWELL ELECTRO MOTOR.

THE armature shown in the engraving is one which is in use in connection with the Stockwell motor in America. It is of the Siemens shuttle-wound type, and consists really of two separate armatures placed at right angles to each other. The commutator has four segments, and the terminals of the wire on each part of the armature are connected to opposite segments. The latter are not made parallel with the spindle, but are helical in shape, so that there is no break in the circuit at that point, since the brush passes the current to one armature before leaving the other. By this arrangement only one armature is in action at one



time. Taking the one to the right, for example, it yields its maximum effect during the quarter revolution when the polar faces of the armature are approaching the pole pieces, and until they come directly opposite each other. During the next quarter revolution the armature is cut out of the circuit entirely; in the third quarter it again comes into the circuit until occupying the same relative position as in the first quarter; and, finally, in the fourth quarter it is again cut out. But during each of these idle periods of the armature to the right, that to the left comes into circuit, and goes through relatively the same cycle of operations.

THE DISTRIBUTION OF ELECTRICITY BY UNDERGROUND CONDUCTORS.

AN ideal underground system for the distribution of electricity must secure the adequate protection of the cables when laid, and provide easy and rapid means of repair; while it is desirable also that it shall be possible to make extensions and increase the number of conductors without fresh excavations being rendered necessary. The inventors of the Callender and Webber system, a working example of which is on exhibition at the works of the Anglo-American Brush Electric Light Corporation, claim that they have fulfilled the requirements stated, and have introduced important advantages in other respects.

Theirs is a "drawing-in" system, its speciality consisting in the provision of a separate "way" for every cable, each way being a closed passage impervious to water or gas, completely separated from all other ways and earth by a wall of material in itself a fair insulator. The danger of "earths" or "contacts" is thus reduced to a minimum, as it would be necessary to penetrate both the wall of the case and the dielectric of the cable before the insulation could be destroyed.

The cases are constructed of a bitumen concrete, possessing great strength, giving very high results when tested with respect to crushing, tensile and breaking strains, and in the composition of which only pure

natural bitumen is used. No coal tar, pitch or other product containing light volatile oils is employed, so that the cables are absolutely unaffected by the material of which the cases are composed. This concrete is said to be impervious to water, and is unaffected either by the gases or acids found in the soil. It does not expand or contract. It is strong, capable of sustaining heavy weights without injury, and is elastic, bending rather than breaking.

The cases are preferably rectangular in form, pierced with holes or ways of a diameter suitable for the cables to be drawn in. They are generally six feet in length, but are also made in lengths of from three to twelve feet. The joints are formed by paper tubes or by saddles closing round the cases cemented together by molten material, similar in composition to that of which the cases are made, the whole then forming one homogeneous mass.

Light shields are fitted in the ways and kept in position by mandrils to ensure that no bitumen shall penetrate during the process of jointing, and that no rough edges present themselves at the joints to interfere with the drawing of the cable or injure it in its passage. Drawing-in boxes or man-holes of the usual type are provided wherever necessary, to give access to the cables for repairs or for providing additional leads.

Bitumen concrete exposed to every variation of climate, to cold and heat, wet and dry, is practically imperishable, and there is no doubt that these cases will last generations. This material having practically no coefficient for expansion, one of the greatest difficulties in actual work is non-existent, and joints once made between the cases are not liable to part or buckle up in cold or hot weather; it is also one of the best non-conductors of heat, and in respect of both these points it is immeasurably superior to iron.

The cost of laying is small, and jointing is not more expensive than for ordinary iron pipes, whilst a more effectual joint can be produced.

The ways are smooth and free from the cutting edges found in iron castings. There can be no rust, and, consequently, when cables have to be drawn in and out there is much less friction and less liability of injury to the insulation. Cables drawn into these ways remain loose, without adhering to the bitumen concrete, and by the exercise of a little care after they are first placed in position they will permanently retain this freedom of movement, so that a faulty section can be withdrawn and replaced easily at any time.

The bitumen concrete employed is made under the patent of J. W. Butler, and the system of laying is that patented by T. O. Callender and Major-General Webber, C.B., R.E.

JARMAN'S ELECTRICAL TRAMCAR SYSTEM.

THE cry is "Still they come!" though the number of inventors of electrical tramcar systems is limited; the list of original inventors still more so. Nevertheless the addition of each new comer to swell the ranks of those who are labouring earnestly and hopefully in the cause of electric locomotion should be welcomed as a fresh means of gaining the public ear and eventually the public support. The most recent exhibitor in this direction is Mr. A. J. Jarman, of Brixton Road, London, and although his system is at present only exemplified by means of a model line and car, yet sufficient can be learned from this to give a fair idea of what can be accomplished in practice. The object of Mr. Jarman's invention is to permit a suitably constructed electro-motor to transmit power with as little friction as possible, and to give a reverse motion to such motor and its vehicle without the employment of any of the usual reversing gear, such as bevel wheels, mitre gear, large and small crown racks, clutches and the like, and without the use of the well-known double brush arrangement. The inventor fixes two armatures upon one axle or spindle, and employs two sets of field magnets as shown in fig. 1. A toothed or other suitable wheel B, is fitted upon any convenient part of the axle, in this instance in the middle, for communicating the motion of the armature through other wheels to the car, as in fig. 2, where F represents the toothed wheel of the motor axle. This communicates motion to G, and this again to H, which drives I, whose axle, J, is that to which the car wheels are attached. The wheel, I, is shown as bearing revolving teeth made of pieces of round bar steel, or other suitable metal or alloy, fitted into holes in the side rims of the wheel truly bored to receive them. By adopting this form of wheel, says Mr. Jarman, friction becomes greatly reduced.

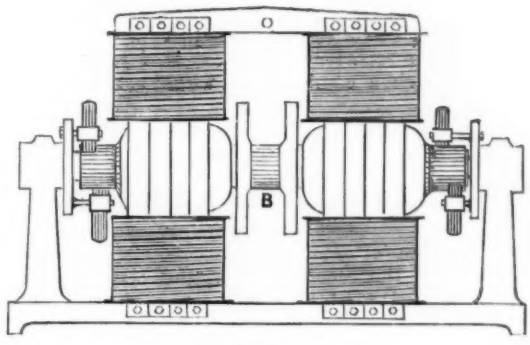


FIG. 1.

It will be seen that each motor has a collector and brushes of its own, which are so arranged that one armature can revolve in one direction and its companion in the other. This is accomplished by mechanism which lifts the brushes off one armature and at the same time it places the brushes on the second. The inactive armature therefore acts as a fly-wheel to that which is at the moment in active operation, and gives a steadier motion. Another advantage claimed by Mr. Jarman for this method of coupling is that as a single armature is liable to become heated by long-continued action, the setting in motion of the second armature during the return journey allows the first to cool down rapidly as it revolves in a state of inaction.

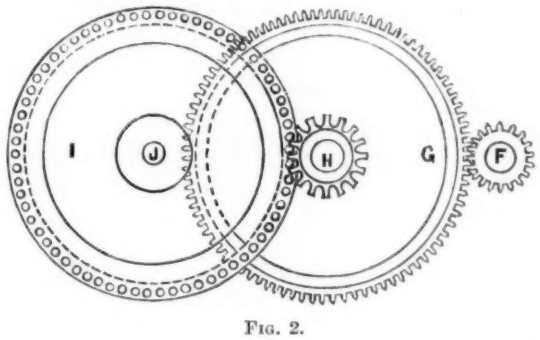


FIG. 2.

The electro-motor of Mr. Jarman's design can be fitted to any existing tramcar, and the inventor intends to attach a novel guard to his cars fitted with brushes, constructed like the "cow-catcher" employed on the American locomotives, which is to run within an inch of the ground, and effectually throw off any obstacles, and prevent them from getting under the wheels.

The motive power for the Jarman system will be obtained from secondary batteries placed under the seats, whence they can be withdrawn by a slide at the end of the car, and re-charged cells substituted for those exhausted. It is intended to proceed forthwith with the construction of a full-sized car, fitted with Mr. Jarman's electro-motor, and to submit it to the test of practical working on a metropolitan tramway.

We may add that the model exhibited weighed about 1½ cwt., and readily turned three curves of a six feet radius.

There may be certain advantages attached to Mr. Jarman's plans of operation over other better known and very similar systems, but we think they, if existing, are more than counterbalanced by incompleteness in the matter of obtaining power and variation of speed.

It is the last straw which "brakes" the camel's back, so we cannot refrain from quoting a specimen of newspaper technicality. Says the *Standard* of Tuesday morning :—"As the motors are *unipolar*, one in front of the armature the other in rear of it, the electric motors might be made to act as a brake, for if the current were turned on to both, the one motor would oppose the other, and the car would be brought to a dead stop."

A unipolar motor in front of an armature, and another in the rear of it is indeed a novelty in which Mr. Jarman doubtless takes a just pride; probably, however, the reporter of the *Standard* really meant to say that such a combination would act as a "brake" down.

THE MARCHANT ENGINE.

IN the issue of *Engineering* for October 22nd a criticism of the recent tests of the Marchant engine described in the ELECTRICAL REVIEW is given. In this criticism an attempt is made to show that owing to the construction of the brake employed the measurements made, and the results obtained therefrom, are "utterly worthless." I think a careful examination into the actual facts will not only show that the results are certainly not only not "utterly worthless," but that a most extraordinary mistake has been made by the writer of the article in question; a mistake which is probably due to forgetfulness rather than to ignorance, as it can hardly be imagined that the writer is really so lamentably ignorant of ordinary mechanical laws as would appear to be the case.

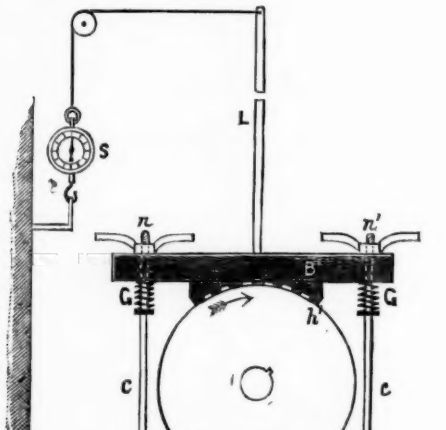


FIG. 1.

In the article in question no importance, apparently, is attached to the part played on the brake by the support, E (fig. 1); but, although some exception might not unreasonably have been taken to the arrangement, I understand that, as a matter of fact, there was a clear space between this support and the ground when the brake was canted over and a strain placed on the Salter's balance; consequently this point may at once be dismissed as playing no part in the question at issue.

Coming now to the part played by the fulcrum, F, fig. 2 shows the equivalent arrangement, A being the axis of the brake, p the turning force due to the friction between the flywheel and the brake blocks, and F the stop. Now the writer in *Engineering* points out that when the nut, n_1 (fig. 1) is tightened the angle α° becomes more obtuse, and inasmuch as the end of the lever, l, banks against the stop, F, a strain is put upon the Salter's balance, S; so far so good, but then he goes on to the astounding statement that when the frictional force of the brake comes into play a further strain, p, is put upon the lever, L, and "when running under such conditions the resistance experienced by the engine simply amounted to the pull at the top of the lever, L, multiplied by the radius of that lever, and *minus the pressure on the point*, F, *multiplied by the horizontal distance of that point from the centre of the crankshaft.*" In other words, the writer practically

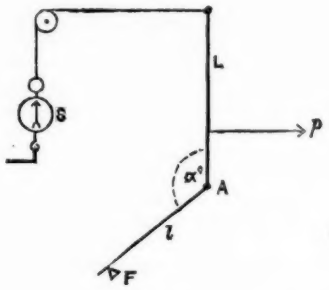


FIG. 2.

asserts that if before the pressure, p, is applied the strain on the Salter's balance is, say, 60 lbs., then if the pressure, p, when resolved at the end of the lever, L, is equal to, say, 80 lbs., the Salter's balance will show a strain of 80 + 60, or 140, lbs.!! It seems almost unnecessary to point out that the strain on the Salter's balance will remain at 60 lbs. so long as the resolved pressure, p, is less than 60, but that the moment it exceeds 60 then the strain indicated will be *solely that due to the resolved pressure*, p.

Of course, if in the experiments readings were taken on the balance when the resolved force was less than the initial strain due to the pressure against F, such readings would be worthless; but, as a matter of fact, I understand that whatever the balance indicated at first, this amount was always exceeded when the engine was running, consequently the pull indicated, multiplied by the length, L, was a strictly accurate moment upon which to base the calculations; and in the absence of other possible sources of error, the results obtained can be considered absolutely reliable.

H. R. KEMPE.

THE COMMERCIAL EFFICIENCY OF DYNAMO MACHINES.

IT is now generally recognised, says *Industries*, that the electrical efficiency of a dynamo machine alone is no indication of its merit, and makers of dynamos, as well as users, are beginning to look more to the commercial efficiency, which alone is of practical importance. There is, however, this difficulty—that in experimentally determining the commercial efficiency of the dynamo, it is necessary to measure the power supplied, an operation involving the use of some kind of mechanical dynamometer, and, therefore, both difficult and expensive. In order to avoid the necessity of measuring the whole of the power, Dr. Hopkinson, about a year ago, invented a method by which the commercial efficiency of dynamo machines could be determined by measuring only a fraction of this power mechanically. In his arrangement two equal machines are employed, coupled both mechanically and electrically, and the power supplied

and measured is only that necessary to make up for losses occurring in both machines, and is, roughly speaking, only from 10 to 20 per cent. of the total power flowing through the machines. This method still requires the measurement of a power mechanically, and is, therefore, not quite free from the objections appertaining to the use of a dynamometer; but the size of the apparatus and the relative importance of any errors are greatly reduced. Since Dr. Hopkinson's arrangement has been published, several scientists have suggested improvements in his method by supplying the extra power not mechanically, but electrically, and recently Captain Cardew has devised another method, by which also only electrical measurements need be taken. In this arrangement it is necessary to have three dynamos of about equal size, and the whole of the power must be supplied mechanically, although it need not be measured mechanically. These conditions cannot always be easily fulfilled, and Mr. A. P. Trotter, in conjunction with Mr. Ravenshaw, has devised another modification, under which the commercial efficiency of a dynamo can be determined by the use of two other dynamos not necessarily of the same pattern. This method has been explained in a letter written to our contemporary the *Electrician*, in which Mr. Trotter points out that most makers nowadays have a good stock of obsolete machines, which might be utilised in the determination of the efficiency of more modern machines. Broadly speaking, Trotter's method is as follows :—Given three dynamos, A, B, C, of which A is a modern machine whose commercial efficiency is to be determined, whilst B and C are obsolete machines of approximately equal output, then three tests must be made. In each test two of the dynamos are coupled electrically and mechanically, according to Dr. Hopkinson's arrangements, the extra power being supplied by the third dynamo, as suggested by Lord Rayleigh. In this way the combined commercial efficiencies of three pairs of dynamos can be found. Let these combined commercial efficiencies be denoted by E_1, E_2, and E_3; E_1 being the combined efficiency of dynamos B and C; E_2 that of dynamos A and C; and E_3 that of dynamos A and B; then the efficiency of dynamo A is given by the square root of E_2 multiplied by E_3 and divided by E_1, and symmetrically for the other two dynamos. This method, which is quite new, and of considerable practical importance, deserves to be well known by electricians; it has this great advantage, that only the loss of power occurring in the three machines need be supplied, and that only electrical measurements need be taken. By using the same instruments for the different measurements, the influence of faulty calibration can, to a great extent, be eliminated, and the accuracy of this method would be absolutely perfect if the commercial efficiency of each dynamo were the same, whether used as generator or as motor. But herein lies a weak point. It is reasonable to suppose that in good modern machines there is practically no differences in the commercial efficiency, whether they are used to supply current or to produce power; but in obsolete machines it is quite possible that there may exist differences in efficiency when used for these different purposes, and thus a slight error may creep into the calculation. However, the method is the best hitherto devised, and a possible error from the cause here mentioned is certainly much smaller than the probable error of a mechanical transmission dynamometer.

The average electrical efficiencies during the test were 91, 78·5, and 89·1 per cent. for the machines A, B, and C respectively. The commercial efficiencies obtained in the way above explained were 87·6, 65·2, and 71·5 per cent. respectively. It is interesting to note that, between the modern dynamo A, and the obsolete dynamo C, there is only a trifling difference in electrical efficiency; whereas there is a considerable difference in the mechanical efficiency, showing that recent improvements have been mainly in the direction of doing away with those losses which may be classified under the term magnetic friction. The electrical efficiency of dynamo B is not quite so good as that of the other machines; but this can be explained by the fact that this dynamo was smaller than the other two, and had, therefore, to be overdriven in the test. It is also interesting to note the efficiency of conversion, which, from the above figures, comes out as follows: In the modern dynamo A, 96 per cent. (neglecting fraction) of the mechanical power supplied to the pulley is converted into internal electrical work. In dynamo B only 83 per cent. is thus converted, and in dynamo C the ratio falls to 80 per cent., thus again showing that recent improvements have been mainly in the direction of a better conversion of power, and not so much in the direction of increased electrical efficiency.

We have been favoured by Mr. Trotter with a set of figures showing the practical application of his method, and, as these are very instructive, we produce them in the table below :—

EFFICIENCY TESTS.

Motor B.			Dynamo C.				
Volts.	Amp.	Watts.	Volts.	Amp.	Watts.	Efficiency per cent.	Average Efficiency.
125	64	8,000	66	56	3,700	46·2	E_1 = 46·8 per cent.
120	67	8,050	54	68	3,680	45·7	
Motor C.			Dynamo B.				
95	53	5,030	66	37	2,440	48·4	
93	51	4,750	63	36	2,260	47·5	
Motor C.			Dynamo A.				E_2 = 62·5 per cent.
118	68	8,000	89	56	5,000	62·5	
120	70	8,400	91	57	5,200	62·0	
Motor A.			Dynamo C.				
125	65	8,100	81	63	5,100	63·0	
125	66	8,250	70	74	5,180	62·8	
Motor A.			Dynamo B.				E_3 = 57·1 per cent.
111	62	6,900	66	62	4,080	59·0	
108	58	6,380	66	53	3,500	55·0	
104	56	5,800	64	52	3,330	57·5	

THE DAFT MOTOR AND ELECTRIC RAILWAY.

THE Daft Electric Light Company has published a new pamphlet descriptive of its motor system, discussing the various questions of safety, cost, revenue, and the like, and touching on a variety of unfamiliar points. Respecting the Baltimore electrical road, a report is given of so recent a date as September 25th, from Mr. T. C. Robbins, general manager of the system of which the line is part. He says: "Its success by the change from horse and mule power to electric power under the Daft system has exceeded my highest expectations. It has largely increased travel on the route, and at a less operating expense than horse power. The road has been running more than a year by electricity with as much regularity as any road in the country. I find less difficulty in getting men to run the motors properly than I do to get men to run the ordinary horse car properly. The road is now being run by persons who, before their employment here, were unfamiliar with electrical affairs. The overhead conductors that have been lately put up to

carry the current overhead at the road crossings are working very successfully. We are now extending the overhead conductor over another branch of the road, which we expect will be completed before many weeks." He then gives the subjoined figures :—

For the year ending September 1st, 1886, the road carried, with two cars propelled by Daft electric motors, 311,141 passengers at 5 cents each	$15,557.05
For the corresponding year ending September 1st, 1885, the road earned, with three cars propelled by horses, 227,155 passengers at 5 cents each	11,357.75
Showing an increased gross earning by two electric cars of ... ... over the gross earnings of three horse cars for corresponding time the previous year.	$4,199.30
The average number of passengers carried per car per annum by electric-power was	155,570
The average number of passengers carried per car per annum by horse-power was	75,718
Showing an excess of passengers carried per car per annum by electric power of ... ... over horse-power per car per annum.	79,852
The average gross earnings per car per annum propelled by electric-power was	$7,778.52
Average gross earnings per car per annum by horse power was	2,785.91
Showing an excess of gross earnings per car per annum of ... ... in favour of electric power per car per annum over horse-power per car per annum.	$3,992.61

The average cost of horse-power per car per day is $6·50. The cost of the electric-power per day on this road is :—

1¼ tons of coal, at $3.50 per ton...	$5.25
An engineer at	2.00
A fireman at	1.50
Oil and waste	6.50
Interest and depreciation of plant	2.75
Making	$12.00

the cost of ample electric-power to run three cars and three motors, which is an average cost per car per day for electrical power of $4.00.

He adds : "When I take into consideration the largely increased earnings per car propelled by electric power over the earnings per car propelled by horse power, I am very favourably impressed with the large percentage shown in favour of electric-power over horse-power for propelling street cars. There is not two miles of street railroad in the country more difficult to operate owing to the unprecedented grades and curves to overcome than the two miles that are being successfully operated here now by electricity. There is not 300 feet of level track at any one point on the road. The grades vary from nothing to 350 feet to the mile, with curves from 40 to 70 feet radius on heavy grades. With more favourable conditions, such as cheaper fuel, easier grades and curves, a much more favourable result could be obtained than on this road."

EXPERIMENTS ON THE MELTING PLATINUM STANDARD OF LIGHT.*

By CHARLES R. CROSS.

NOTWITHSTANDING the fact that the amount of light emitted normally by a square centimetre of platinum at its point of solidification has been adopted as a standard both by the International Electrical Conference and by the United States National Conference of Electricians, but very few experiments have been made to determine whether it can be made reliable and capable of practical use. An approach toward giving the method a practical form was made by W. Siemens, † who proposed to substitute the light emitted by a given area of platinum at its melting point instead of at its point of solidification, and suggested a means by which with this modification the standard could readily be utilised.

The following experiments resulted from a conference of a portion of the Committee on Standards of Light appointed at the Electrical Conference at Philadelphia in 1884. ‡ They had for their object the ascertaining of a single fact, viz., the amount of the average deviation which would arise in a series of measurements of the light emitted by a strip or wire of platinum of given surface when at the melting point.

A few preliminary experiments were made by the writer, in which a measured length of fine platinum wire, four one-thousandths of an inch in diameter, was placed at one end of the bar of a Bunsen photometer, with a gas jet shining through a limited aperture at the other end. A current from a small hand Gramme machine was carried through the wire, which was made to glow more and more brilliantly by increasing the speed of the machine. Following the method of Siemens, the greased disc of the photometer was moved farther and farther from the incandescent platinum, so as to keep the disc uniformly illuminated, until finally melting occurred. The last reading of the position of the disc gave the illuminating power of the wire at melting. An unexpected constancy in the results was found, so that it seemed worth while to make a longer series of such observations, which was done in the following manner. At one end of the bar of a greased disc photometer 200 centimetres (78·74 inches) long was placed a circular aperture, through which shone the light of an Argand gas burner. A platinum wire lamp was constructed, in which a given length of wire was stretched between two fixed knife edges, and held by clips, thus allowing of speedy adjustment of the wire. The disc used was furnished with two mirrors inclined at 45° in the usual manner, and it was always placed so that the two sides as seen by reflection appeared alike—a method of measuring much more satisfactory than the one commonly employed with the Bunsen photometer. The length of wire used was measured between the edges when cold, and allowed to expand freely. An attempt was made to use a slit of given length in front of a longer wire, which was abandoned owing to errors arising from inequality in the length of that portion of the wire whose light passed through the slit when the wire expanded. The use of a small weight stretching the wire tight, as suggested by Professor Pickering and employed by him in a small lamp, presents some advantages, but was discarded from fear of elongating the wire and so causing it to break before complete fusion was reached. Melting was brought about by the use of a slide resistance of German silver wire in circuit with the platinum wire and a dynamo machine. The variable resistance of the slide was lessened until the platinum wire melted, the photometer disc being meanwhile moved repeatedly, its final reading giving the light emitted by the platinum in terms of the light emitted by the aperture opposite.

No attempt has been made in these experiments to determine the absolute illuminating power of the wire, but only to ascertain whether ordinary commercial platinum wire has any practical value for use as a primary or a secondary standard.

Two different sizes of wire were used, whose diameters were ·004 inch and ·006 inch respectively. Wire from two different makers was also used, ordinary wire drawn without special care being taken because of its availability. The length used was always the same when cold, viz., two inches. A very large number of measurements were made, chiefly by Messrs. F. H. Crane and H. E. H. Clifford, students in the laboratory, and careful and accurate observers.

Five sets of observations on successive fusions of wire were made by each observer, and the mean taken. The mean and the average deviation from the mean of a long series of such sets were then found. The tables give the results of the measurements. In all cases the distance between the opposite lights is 78·74 inch (200 cm.), and the diameter of the aperture in front of the gas flame ⅜ inch. The recorded distances are measured from the aperture.

In order to give an idea of the degree of concordance of the separate individual readings, the following sets (Table I.) are taken at random. The numbers given are the final positions of the disc, in each experiment, in inches.

TABLE I.

Diameter of wire = ·004 inch.

Observer *M.*	Observer *N.*
43·7	43·6
43·6	43·7
43·7	43·7
43·6	43·5
43·5	43·8
Mean 43·62	Mean 43·66

A change of 0·1 inch corresponds to an absolute change of 0·007 in illuminating power of opposite light = 1·1 per cent.

Diameter of wire = ·006 inch.

Observer *N.*	Observer *N.*
37·7	37·4
37·8	37·2
37·4	37·4
37·2	36·8
37·2	37·2
Mean 37·46	Mean 37·20

A change of 0·1 inch corresponds to an absolute change of 0·01 in illuminating power of opposite light = 1·0 per cent.

Table II. is given at length as indicating more clearly the variations among consecutive sets of measurements. I.P. denotes the illuminating power of the platinum wire in terms of that of

* Read at a meeting of the American Academy of Arts and Sciences, June 16th, 1886.

† Wied. Ann., 1884, vol. xxii., p. 304.

‡ Messrs. J. Trowbridge, E. C. Pickering, and C. R. Cross.

the opposite light. The average deviation of I.P. is the change in this quantity produced by an increase in the scale reading equal to the average deviation in inches.

TABLE II.

Diameter of wire = ·004 in. Sample A.

Averages of 5 Experiments. Observer *M.*	Averages of 5 Experiments. Observer *N.*
43·6	43·7
43·7	43·5
43·6	43·5
43·7	43·4
43·5	43·4
43·6	43·6
43·5	43·3
43·6	43·6
43·6	43·2
43·5	43·7
Mean 43·59	Mean 43·49
Average deviation ·06 in.	Average deviation ·13 in.
I. P. = ·650	I. P. = ·657.
Average deviation I.P. = ·004.	Average deviation I. P. = ·009.

Tables III. and IV. give the means of the various sets of experiments. Column 1 shows the sample used; 2, the mean of the series taken; 3, the number of observations from which the mean is derived; 4, the observer; 5, the illuminating power; 6, the average deviation in inches; and 7, the average deviation in terms of the illuminating power. It will be seen that the maximum average deviation in I. P. for the finer wire is 1·7 per cent., and for the coarser wire 1·6 per cent. of the total value.

TABLE III.

Diameter of wire = ·004 inch.

Sample.	Mean.	Number of Obs.	Observer.	I. P.	Av. Dev. Inches.	Av. Dev. I. P.
A	43·59	50	*M*	·650	·06	·004
A	43·49	50	*N*	·657	·13	·009
B	43·77	50	*N*	·638	·11	·007
B	43·70	50	*M*	·643	·16	·011
B	44·86	50	*N*	·570	·18	·010
A	45·16	50	*N*	·553	·12	·007
A	43·72	50	*N*	·641	·12	·007

TABLE IV.

Diameter of wire = ·006 inch.

Sample.	Mean.	Number of Obs.	Observer.	I. P.	Av. Dev. Inches.	Av. Dev. I. P.
A	35·37	20	*N*	1·504	0·15	·024
A	37·19	30	*N*	1·249	0·14	·019

In order to determine the possible accuracy of setting the photometer disc, several series of readings (Table V.) were taken, in which two apertures through which a gas flame shone were balanced against each other. These readings were taken with apertures of different sizes, in order to test the accuracy of setting in different parts of the scale; that is, for different relative brilliancies of the lights. Series 3 and 4 were taken so as to bring the disc in the same position as that which it occupied with the ·004 inch and ·006 inch platinum wire.

TABLE V.

Series.	Number of Observations.	Mean.	I. P.	Av. Dev. Inches.	Av. Dev. I. P.
1	50	31·35	2·286	·076	·019
2	50	31·40	2·273	·054	·012
3	50	43·92	0·628	·042	·003
4	50	36·48	1·342	·044	·005

It appears that the average deviation of the different readings when the opposite illuminated apertures were balanced against each other is in general considerably less than that of the readings with the melting wire. The maximum average deviation of I. P. is 0·8 per cent. of its total value; the minimum value is about half as great.

Marked differences in the illuminating power of the platinum wire of the same diameter on different days were observed, contrasting strongly with the uniformity of the results of successive measurements. This undoubtedly arose from changes in the quality, and hence in the illuminating power of the gas, as the height of the flame was kept constant. In future experiments I hope to obtain a more constant standard by using a moderator lamp with aperture, or else by employing the pentane burner.

A consideration of the results given in Tables III. and IV. shows that the light emitted by a filament of commercial platinum at the melting point is quite constant in successive measurements, and it appears to present greater uniformity than many of our commercial standards. There is little doubt, moreover, that by the use of a wire longer, and perhaps of larger diameter, the results would be improved, as there would be less liability to error from the cooling of the ends of the wire by contact with the metal supports (an action, however, which can easily be removed altogether), and from accidental minute inequalities in the length of the wire used. It would also be desirable to use platinum of better quality than is usually found in commercial wire, and to have special care exercised in drawing to insure accurate cylindricity.

It is also evident that such a wire as I have used cannot at best be employed except as a secondary standard, since the ratio of the luminosities of the two gauges of wire employed is not at all in the ratio of the projection of their surfaces.

Still further, a difficulty may arise in the use of a melting platinum wire or strip even as a secondary standard from variations in the physical condition of the metal due to cracking, occluded gases, or other causes. No certain evidence of this was observed with the samples of wire employed, but I am not at all sure that it may not occur with different specimens of commercial wire. From a few preliminary experiments of a series still in progress it appears probable that successive heating and cooling, or continued heating of the wire even under ordinary atmospheric pressure, tend slightly to raise its point of fusion, an action which Edison has shown* to be carried to an extreme degree when continued heating in vacuo is employed. Thus, in one experiment the wire was heated by the current and cooled from one to ten times, and then carried up to its melting point, photometric readings being taken as in previous experiments, with the following results. The wire was ·006 inches in diameter. Each value given is the mean of five measurements.

	Mean Reading.
Without reheating	37·65
Reheated once	37·42
,, twice	37·42
,, 3 times	37·62
,, 4 ,, ...	37·26
,, 5 ,, ...	37·06
,, 10 ,, ...	37·26

The lesser readings indicate greater luminosity of the melting wire.

In another experiment, the wire in its ordinary condition melted when the reading (mean of five measurements) was 37·8 inches. After annealing in a Bunsen flame, the mean reading at melting (for five experiments) was 37·2 inches. After heating to a yellow heat by passing a current of electricity through it for half an hour, the reading at melting (mean of 23 measurements) was 36·9 inches.

If further experiment should show conclusively that the light emitted by melting platinum is variable beyond narrow limits, it is clear that any photometric standard based on the luminosity of *melting* platinum will present no advantage over those standards now in ordinary use, unless specially prepared platinum freed from gases and consolidated by Edison's process of heating in vacuo is found to be available. Probably solidifying platinum, provided its point of solidification is sufficiently definite, would be free from this objection, although this can hardly be accepted without experimental proof.

Rogers Laboratory of Physics,
June, 1886.

* Proceedings of American Association, 1879, vol. xxviii., p. 173.

ELECTRIC MOTORS IN AMERICA.

WE have given some account in a previous number† of the Sprague electric railway system. In connection with electric motors there appears in the *Electrical World*, of New York, an interesting description, which, though professedly dealing with the work of Mr. Sprague, is founded to a great extent upon principles not unknown in this country. While recognising the ability with which some of the applications have been made, it is impossible to allow Mr. Sprague's right to what appears to be claimed as his "main principle" in self-regulation, viz., that under varying loads or speeds, regulation is to be obtained by an inverse varying of the strength of the fields. This principle is at any rate as old as the differential motor of Ayrton and Perry.

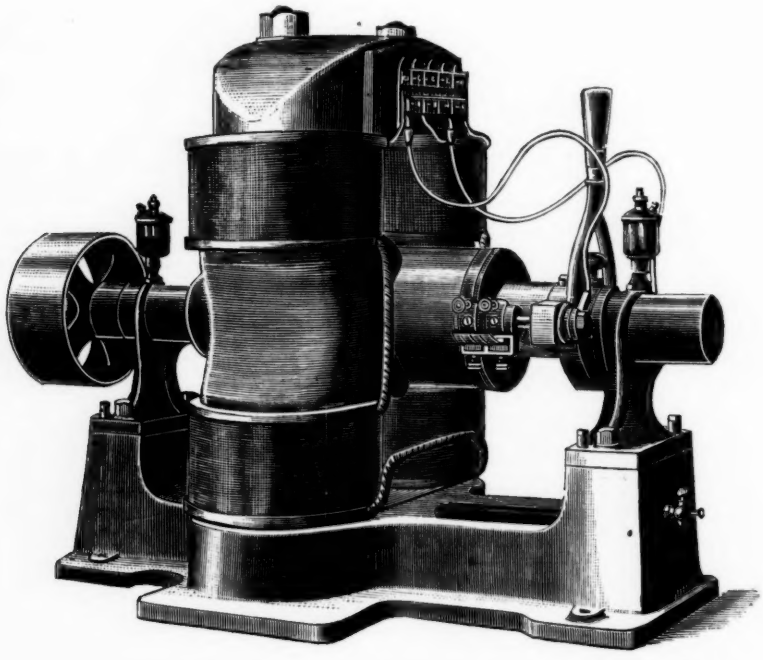
Some idea may be obtained of the operation of different classes of motors, under various conditions of supply, from the following general explanations:—

A motor when running may be looked upon as a

† ELECTRICAL REVIEW, October 22nd.

dynamo machine propelled by a current; it has a field-magnet like any other dynamo, it has an armature situated in that field which, either because of the attraction and repulsion of the lines of force, or of the double attraction and repulsion of the poles which are set up in the armature acting on the poles of the field-magnet, is caused to rotate. This armature rotating in the magnetic field has an electromotive force developed in it which is precisely of the same kind as would be developed were the motor driven by a belt instead of by a current. The strength of this electromotive force depends upon the resulting strength of field and the speed of the armature. This electromotive force, which may be termed a *motor* electromotive force, is ordinarily called the counter electromotive force because it is opposed to that of the line current which is flowing into the motor. The difference between this line electromotive force and that of the motor is what may be called the effective electromotive force, and determines, in combination with the resistance of the circuit, the strength of the current which will flow in a circuit into which these elements enter. In any case of a special transmission of power, unless carried out under certain well-defined laws based either upon a constancy of current or constancy of potential at some definite part of the circuit, is unsatisfactory, but if made according to a law no difficulties present themselves.

We will briefly consider the action of these different kinds of machines on two classes of circuits only. First, on the constant current circuit. If a series wound machine be placed upon such a circuit, the same current passing through the field magnet, it will develop a constant torque, which torque is directly proportional to the strength of the field magnet and to the current in the armature. If the mass of iron is sufficiently great, this torque will be directly proportional to the effective ampère-turns in the field magnet, and the work done will be directly proportional to the speed. If the machine be at rest there will exist a difference of potential at the terminals of the machine equal to the product of the current and the resistance of the machine. When running, however, an electromotive force will be developed in the machine, and the potential at the terminals of the machine will rise by the same increment. The work done may be likewise



single transmission from a dynamo to a motor the combination of these two determines the differences of potential which exist in the different parts of the circuit, which difference of potential determines the strength of current which will flow in any derived circuit. This counter electromotive force likewise determines the efficiency of a motor or a system of transmission of power.

Motors may be described as belonging to one of three different systems. First, those in which the field magnet is excited by a coil in parallel circuit with the armature, that is, in shunt relation thereto; second, those in which the field magnet is in series with the armature circuit; and third, those in which there is a combination of these two circuits. There are in addition a very large variety of each of these classes, different conditions demanding different performance. Furthermore, similar machines may be placed upon three different kinds of circuits, their performances varying widely in each case. These three conditions are:—First, the case of special transmission with varying potential and current; second, constant current circuits in which the main current is kept at a constant quantity; and third, constant potential circuits. The expressed by the product of this counter electromotive force and the current, or e C, and is independent of the resistance of the machine. The resistance, however, determines, in combination with the other elements, the total efficiency of the motor. The total energy expended is the product of the difference of potential existing at the terminals of the motor and the current flowing, or E C. The efficiency then is $\frac{e\,C}{E\,C}$, or $\frac{e}{E}$, and the heat wasted $(E - e)$ C.

When running at any particular speed the work will be increased directly as the field magnet strength is increased. So also will be the economy. The heat wasted with any given resistance in a machine under these conditions is a constant. The direction of rotation of such a machine can be reversed by reversing either the armature circuit or the field circuit; if both circuits are reversed, then the machine will run in the same direction. For many classes of work this kind of machine is exceedingly useful, because it admits of a great range of hand control. If such a machine, however, be put on ordinary work, and this work be lightened up, the machine will run faster and faster, and unless the field is weakened or the brushes

are shifted to check it, the speed will practically increase without limit. Every change of speed and every change of load is accompanied by a corresponding change in the potential which exists at the terminals of the machine. Moreover, on a constant current, the motors being in series with each other and with lamps, this continual variation of potential is apt to cause trouble on the circuit, especially if the machines are not automatic, since, as already stated, with any fixed field the torque is constant, the work done is directly proportional to the speed. The machine has the highest efficiency when running at the highest speed.

With shunt machines, however, the action on the constant current circuit is much different. Here the current is divided in two circuits, such division, when the motor is at rest, being inversely proportional to the resistances of the two parts of the circuit. With such a motor, the field is weakest when the machine is at rest, and its torque or rotary effort is also very weak. If the load be not too great, as the speed of the machine increases a counter electromotive force is set up, the potential at the terminals of the armature and field magnets rises, the current in the armature diminishes, and that in the field magnet increases. Provided there is sufficient iron in the field magnets, the torque or rotary effort will vary in a decreasing ratio until one-half of the current is flowing through the field magnet. At this moment the machine will be doing its maximum amount of work, and at less than 50 per cent. total efficiency. If the work be lightened, the machine will increase its speed until, when the work is entirely removed, there will be practically no current through the armature; all will have been shunted through the field magnets, and the potential at the terminals of the machine will be at the maximum. Such a machine will do the same total work at two different speeds and efficiencies.

If a machine be wound with a double set of coils, it will behave very much the same as a shunt machine does, its field magnet being strengthened in a more or less rapid ratio, or being kept constant, depending upon whether the series coil is cumulative or differential.

Because of the fact that constant current circuits in ordinary use deal with small currents and very high electromotive forces, and do not admit of such perfect regulation, Mr. Sprague has preferred ordinarily to work the constant potential circuits, although some of his machines are running on the constant current circuits for other than automatic work, that is, for work where the speed is under control and where the work done for a given speed is constant.

There are two ways by means of which a constant current motor can be governed. One consists in automatically changing the counter electromotive force by changing the position of the brushes on the commutator to positions more or less removed from their normal one. To this objection is offered because the proper position for the brushes of any machine is at the points of least sparking. The other method consists in varying the counter electromotive force by automatically weakening the field as the load is diminished, or strengthening it as the load is increased. Several methods have been proposed for doing this, generally by the action of a centrifugal governor. To this also many objections are raised. Mr. Sprague, desiring to get rid of all such rapidly moving adjuncts to motors, is now engaged on a totally new system which promises, he thinks, entire freedom from these defects.

On constant potential circuits the behaviour of these different classes of motors is entirely different.

A plain series wound motor when there is sufficient iron in the field has a torque proportional to the square of the current flowing through it. It is capable of exerting a great rotary effort and doing a large amount of work at a slow speed. The range of speed for different loads is, however, great, and the motor is entirely unfitted for ordinary work where steadiness of speed is an object; as the load is diminished, the speed increases, and, if thrown off entirely, the motor will run faster and faster, the field continually growing weaker, and the armature all the time accelerating its speed in a vain attempt to generate an electromotive force equal to the initial. For some classes of work, this kind of a machine, with some essential modifications, is exceedingly useful.

On the other hand, the shunt wound machine will run fairly well on a constant potential circuit. The field, being excited independently of the armature, is constant, and since the load varies with the motor electromotive force, and the field is constant, it follows that the speed must vary with e. The torque is proportional to the current in the armature, and the speed will be slowest with the greatest load and fastest with the lightest, that is, when $e = \mathrm{E}$. The lower the resistance of the armature, the less the variation in speed.

It is with the third class of motors, when used on constant potential circuits, that the difficulties which are involved in the governing of a motor entirely disappear, and, without the use of any such apparatus as centrifugal governors or movable contacts, it becomes possible to satisfy the most exacting conditions, both as regards efficiency, steadiness of running, power to start under very heavy loads, and freedom from sparking.

When Mr. Sprague first proposed his constant speed machines for constant potential circuits, he enunciated the following proposition :—

In a motor with the armature and field magnet independently supplied, the work which the motor will do in a given time, its economy and efficiency, are all independent of the strength of the field magnet, provided the translating devices intermediate between the motor and whatever is the recipient of its energy are not limited as to the rate of transmission of the motor speed; and that in all cases where a motor is working on a constant potential circuit and not up to its maximum capacity, in order to increase the mechanical effect either of speed or power, or both, or to compensate for any falling off of the potential on a line, it is necessary to weaken the field magnets, instead of strengthening them, and *vice versâ*.

The strength of the field determines the speed at which a motor must run to get a required efficiency. With a given initial potential at the armature terminals, no matter how the load varies from the maximum allowed, the speed may be maintained constant by changing the strength of the field; such strength being diminished as the load is increased, and, *vice versâ*, increased as the load is diminished.

These facts, which are well known in this country, may be demonstrated as follows :—

Let us consider the motor current as derived from mains having a fixed difference of potential, and the motor with its field and armature in shunt relation. In this case the armature runs with a velocity dependent upon the strength of field, the initial potential, the number of turns, resistance, &c., of the armature, and the load, and a counter electromotive force is set up which regulates the armature current. The higher the speed the greater this counter electromotive force. Let E be the initial and e the counter electromotive force, and r the resistance of the armature. The current flowing in the armature is then $\frac{\mathrm{E} - e}{r}$. With a given armature and given field e varies with the speed. The power at any given speed and strength of field varies with the current, and with any given current varies with the strength of field. The total work done is the product of the speed by the work per turn, and since the speed is as e and the work per turn as the current $\left(\frac{\mathrm{E} - e}{r}\right)$ the total work done is expressed by $\frac{e\ (\mathrm{E} - e)}{r}$. The efficiency is the ratio $\frac{e}{\mathrm{E}}$. It will be seen that both these expressions—the total work done and the efficiency—are independent of any function of the field, but depend only on the initial and counter electromotive forces and the resistance of the armature, and

any given value of e can be attained with any strength of field by attaining proper speed.

Considering the speed of machine constant, its field alone being varied, and differentiating the expression for work done, $\frac{e(E-e)}{r}$, we have $\frac{de}{r}\left(E-2e\right)$ as the rate of variation of work.

It follows then that to maintain the speed constant with a current of constant potential under varying loads, when the load increases so that the speed would naturally decline, the field is weakened, the counter electromotive force diminished and armature-current increased, the tendency to reduced speed is counteracted, and there is an increase in the mechanical effect—power. For a decreased load the field is strengthened, the counter electromotive force increases, the current decreases, the speed remains the same, and the power is decreased.

To maintain speed or power constant under varying initial potential, if the potential at the motor terminals increases, these mechanical effects increase or tend to increase. By strengthening the field an increased counter electromotive force is produced, so that the increased power or speed, or the tendency thereto, is counteracted, and this counteraction may evidently be itself considered a decrease in mechanical effect, whether the regulation is performed simultaneously with the increase of potential or before or after such increase. If the regulation is performed simultaneously, with a gradual change of potential, there may be less change in counter electromotive force or armature-current; but there is still the counteracting of the tendency to increased mechanical effect, which counteracting is itself a decrease of mechanical effect. For a decreased or decreasing initial potential, the field is weakened to counteract the decrease in mechanical effect which would otherwise occur, and therefore to produce an increased mechanical effect.

Hence to change the speed or power of a motor on a circuit of constant potential, the speed or power is increased by weakening the field, which produces a decreased counter electromotive force and an increased armature-current, and consequently the increased mechanical effect desired; and such mechanical effect is decreased by strengthening the field, and thus increasing the counter electromotive force.

In brief, then, Mr. Sprague's method of regulation consists in strengthening the magnetising effect of the field magnet coils of the motor to decrease the mechanical effects, such as speed or power, or both, and *vice versa*, weakening such magnetising effect to increase the mechanical effects, and under varying loads the speed is maintained constant by an inverse varying of the strength of the field magnets.

This may be accomplished in two ways, one by varying the field circuits by a mechanical governor which responds to any variation in the speed of the motor. This, however, is not satisfactory, and Mr. Sprague's ordinary method of working is to make use of certain coils in series with the armature and dependent upon it, which coils have a resultant magnet action which is opposed to that of the main coils of the machine. While the main principle is the same, Mr. Sprague has a number of different methods of applying it. The first has a series coil in series with the armature, and its action in the above laws will be understood from the following description. All these machines, it should be said, could be used as constant speed machines on constant current circuits, provided the field coils are properly proportioned for the current which they would have to carry, but with certain disadvantages, as will be shown.

The magnetic moment of a coil may be defined as the product of the ampères flowing therein by the number of turns, and if the main and governing coils are practically similarly situated with regard to the field magnet cores, the magnetic field may be considered as proportional to the effective magnetic moment; that is, to the difference of the magnetic moments of the shunt and series field-coils, so long as we are working on a straight or nearly straight line characteristic. This characteristic can be determined for any particular cores in any of the well-known ways; for instance, by running the motor as a dynamo at a constant speed, passing variable known currents through the field-coils, and noting the potential existing at the free armature terminals,

(*To be continued.*)

LIVERPOOL EXHIBITION AWARDS.

THE exhibitors at the Liverpool Exhibition, having made their presentation of £1,500 and sundry accompaniments to Mr. Lee Bapty, the general superintendent, are now presented in return with their diplomas for gold, silver, and bronze medals and for honourable mention. The exhibition will close on or about the 8th of next month, and it will then only remain to call upon the guarantors to meet that deficit in the accounts which is now looked upon as inevitable. Gold medals are awarded to the Liverpool Electric Supply Company, to Messrs. Marshall Sons & Company, of Gainsborough, and to the Anglo-American Brush Electric Light Corporation, all of whom participate in the operations connected with the electric lighting of the building, as referred to in our issue of October 8th. Messrs. Perry & Cox, who exhibit a model of a house, showing a complete installation of electricity as adapted for domestic use, comprising lights, bells, burglar alarms, and lightning conductors, are the only other electricians receiving a gold medal. Messrs. Robey & Co., who exhibit a horizontal high speed engine (fitted with patent electric governor) driving on the same bed plate a dynamo made by Mr. Greenhill, and also a vertical engine combined with dynamo, are awarded a gold medal for dynamo and a silver medal for engine, but the list does not specify which. The only other engine thought worthy of a gold medal is the Armington and Sims, exhibited by the makers, Messrs. Greenwood & Batley, of Leeds. This engine is shown working a Jones's patent dynamo, which maintains a number of incandescent lamps on and about the stand. The India Rubber, Gutta Percha and Telegraph Works Company has a very fine show of its products, comprising in their various forms and different stages of manufacture, India rubber, gutta percha, and ebonite, as well as electric light apparatus and telegraph material. A gold medal is allotted to this firm for the excellence of its exhibit. Messrs. John Tullis & Son for belting, and Messrs. John Wilkes & Sons for wire, also obtain gold awards. The following are recipients of diplomas for silver medals:—Messrs. R. E. Crompton & Co. (apparatus for controlling electric light for ship use), Messrs. Clarke, Chapman, Parsons & Co. (exhibit including a 250 light patent electric generator for ship lighting). The Coalbrookdale Company (Elwell and Parker's patent three cylinder engine for driving dynamos), Globe Electrical Company (electric lighting appliances), Mr. J. C. Sellers (patent flat cables), and Mr. Traill (models of electric tramway and car). Messrs. Dorman and Smith are distinguished by being awarded two silver medals, one for Raworth's patent electro-magnetic log for measuring the speed of ships at sea, and the other for the general excellence of their electric light fittings and apparatus. Coming to the bronze medals we observe that one is to be bestowed upon the Phosphor-Bronze Company, and a natural suggestion is that an opportunity is here afforded of paying a graceful compliment to the company by having the medal made of their own phosphor-bronze. The "Tower" engine, the "Chandler," and the "Immisch" motor obtain only Honourable Mention in company with many other exhibits, which probably, to those chiefly interested, appear as worthy of gold medals as Stassinopulo's Turkish delight, Suppini's sausages, Wolfschmidt's Kummel, Parelius and Lossius's dried cod fish, or Messrs. T. W. Beach & Sons' real jam.

The Volta Prize.—The Minister of Public Instruction has just fixed the date for the competition for the Volta prize. This prize, the value of which is 50,000 francs (£2,000), will be awarded to the author of a discovery which will render electricity capable of being put economically to one of the following applications: as a source of heat, of light, of chemical action, of mechanical power, of means of transmission for despatches, or lastly, for the treatment of diseases. It will be awarded in December, 1887. The competition will be open until June 30th, 1887, and is open to scientific men of all nations. A committee nominated by the Minister of Public Instruction, will be appointed to examine the discovery specified by each competitor, and to determine whether it fulfils the required conditions.

NOTES.

The Incandescent Lamp Trade Combination.—The latest information on this eventful topic is that the Edison-Swan Company is inclined to consider any proposal the trade may choose to make with respect to manufacturing incandescent lamps under a royalty. If such a course be amicably arranged it will perhaps be the best for everybody concerned, for although the Company will then virtually hold the monopoly of lamp patents, a proposition to pay a reasonable royalty will not be unacceptable to the trade, and in the event of a rupture in these proceedings the Edison-Swan Company would then certainly insist upon its rights, as given to it by the result of the recent trial, the probability being that the different members of the trade would then be dealt with one at a time, as was the case in the telephone law suits. On the other hand, should the Edison-Swan Company prove unreasonable, a combined defence would have a much better chance of effectually succeeding, and even should success at first not be obtained on the present litigation, the company would have to consider the advisability of provoking the collective hostility, backed by the means, of the whole trade. Moderation on both sides may overcome a great difficulty, but to enable the trade and all interested in the incandescent lamp question to better consider the question of fair and reasonable terms, a meeting is convened for Monday, 8th November, at the Cannon Street Hotel, at three o'clock, at which it is hoped that the whole of those interested in the electric light industry will be represented. The meeting will probably be under the presidency of some well-known gentleman, who, without being immediately connected with any one system, may be generally desirous of the welfare of the electrical community. We would suggest that Lord Bury should be invited to occupy the position. Messrs. Woodhouse and Rawson propose to put themselves in the hands of the trade so far as settling their action with the Edison-Swan Company or the continuation of the litigation is concerned, and will abide by the decision of the meeting provided that the cost of the appeal, if made, is previously guaranteed. The expense will, we understand, not exceed the sum of £2,500. As representing the electrical trades in this country, we have been asked to act as treasurers to the fund, should it become necessary to call for such. Beyond drawing the attention of the trade and users of lamps to the fact that the only opportunity likely to occur for preventing an undue rise in the price of such lamps is now offered, and that a generous response is at once necessary, we need not further refer to the views we have taken on the subject, except by calling attention to our article in the last issue of the REVIEW, and by expressing our desire for a speedy and amicable settlement satisfactory to both sides.

The following arrived at the moment of going to press :—"I was glad to see your article in last week's issue, as I believe it correctly expresses the views of those interested in electric lighting matters. With regard to myself, I think that the matter is a much larger one than is generally supposed, and that although Messrs. Woodhouse and Rawson have carried on the matter up to the present, yet I do not think it should be left in their hands—not that I think they have not handled it well, as I think they have taken it up in a most plucky and energetic way—but the interests involved are so large and of so much interest (not only to makers of engines, dynamos, and other plant, if not also to installers and users, but even to those in subordinate positions) that a meeting should be called—not as was done, by Messrs. Woodhouse and Rawson—by someone like yourselves who are known to be impartial. At this meeting, if Messrs. Woodhouse and Rawson are willing, as they probably would be, it should be decided whether the Swan-Edison patents are to be acknowledged on a reasonable royalty to be paid by those manufacturing incandescent lamps, or whether the appeal is to be fought. It would be a most lamentable thing if the electric lighting industry were brought into the same condition as the telephone industry. To those who were engaged in the latter business in the early days, the similarity between the two will be most striking. I hope that those engaged in electric lighting will put their shoulders to the wheel, and help to prevent a similar result, as we must all help. Although I am but remotely connected with the result, I would be glad to subscribe to a guarantee fund, if one were started.—R. A. NEVILE."

Electrical Lighting in Yorkshire.—The *Bradford Telegraph* states that the local Woodhouse and Rawson Company has the contract for the Saltaire Exhibition lighting, and is also making arrangements for an electrical railway there. In addition, the company is making installations at Messrs. Briggs, Priestley & Sons' mills, at Laisterdyke and Thornton ; in the Saltaire plush department ; Campbell and Harrison's wool combing mills ; S. Smith and Co., Horton dye works ; the Technical College chemical department ; H. Foster and Sons, Thornton ; L. Crossley & Co., Halifax ; and S. Walker & Co., Lindley, Huddersfield.

Electric Lighting Progress.—We learn that Methil Dock, Wemyss, Fifeshire, is being illumined by Messrs. Laing, Wharton and Down, with the Thomson-Houston system ; also that the Plymouth Works, at Merthyr Tydvil, are being fitted up by Mr. Howell, the local agent of Messrs. Crompton & Co. The Edison-Swan Company is, we understand, busily engaged in placing an installation at Werrington Park, near Launceston ; in fitting up the National Provincial Bank, Bishopsgate ; and the Athenæum Club.

Electric Lighting at the Yorkshire College.—The new Yorkshire College buildings, at Leeds, are finally lighted by a very excellent electric lighting installation, erected by Mr. Wilson Hartnell, of Leeds, assisted by Mr. Farrer. The installation comprises one 4-unit Crompton compound self-regulating dynamo, capable of driving from 130 to 140 lights. The power is obtained from one of Fowler's horizontal high-pressure engines, fitted with one of Hartnell's patent governors of the latest type. The lamps are divided into three main circuits and again sub-divided for each department, and there are also auxiliary switches for special additional lights. The lamps are Edison-Swan latest pattern collar lamps of 110 volts, 16 C.P., and the wires are for the most part laid in grooved woodwork, painted and decorated to harmonise with the surroundings. So far the lighting has worked extremely well, and has given complete satisfaction.

Ship Lighting.—On Saturday last the official trial of the electric lighting installation on board H.M.S. *Lawrence* took place at Gilbrook Yard, Birkenhead. The *Lawrence* is a despatch boat, built by the firm of Messrs. Laird Bros., of Birkenhead, for the Indian Government, and is elegantly fitted for the use of the Viceroy and suite. The installation consists of two Goolden-Trotter A dynamos, giving 8,800 watts each at 400 revolutions, coupled direct to a pair of Willans three-cylinder compound tandem engines. There are 125 Edison-Swan lamps, giving 20 C.P. at 80 volts, which are placed in Trotter dioptric shades throughout the ship. The fittings are of the Admiralty pattern ; but in the saloon and chief cabin they are of a more ornamental character, and are electro-plated. There is, further, a yardarm reflector, fitted with eight 50 C.P. lamps, for use when the vessel is coaling. The dynamos are placed in a room on deck, an arrangement which will allow of ample ventilation, presenting a strong and favourable contrast in this respect to the usual position of dynamos on board ship. The entire work of the installation was carried out without dock-yard assistance by the firm of Goolden and Trotter within five weeks of the commencement, the vessel being fitted closely within the lines of the usual Admiralty specification for ships of the Royal Navy.

Mr. Jopp, the Director of Stores, was present on behalf of the India Office, Mr. Hudson being the inspecting officer, in the unavoidable absence of Sir Edward J. Reed, M.P., K.C.B. Mr. John Laird and Mr. Henry Laird were also present. The dynamos ran extremely well, were perfectly cool, and quite sparkless at the commutators, at some fifty revolutions under the contract speed. The lamps, also, were the subject of some remark; for, while giving a light of fully 20 candles at 80 volts, when the speed was reduced and the voltmeter indicated 50 volts, their light appeared to be nearly 15 candles, and the ship was still well lighted. Altogether, the installation was a remarkable one. Towards the close of the inspection, Mr. Jopp, in the presence of the assembled company, in a neat speech tendered his warm thanks to the contractors and Mr. R. A. Scott, their superintendent, and expressed his gratification at the manner in which the work had been done. Some of those present also declared that the *Lawrence* was better lighted than any other ship at present in H.M. service. Messrs. Goolden and Trotter have also finished the installation of the troopship *Dalhousie*, the official trial of which takes place this week.

Electric Lighting in the Navy.—The *Rattlesnake*, the first of a newly-designed class of torpedo gun vessel, is now ready for delivery from the contractors, Messrs. Laird, of Birkenhead, and will be at once completed for service in the Royal Navy. The *Rattlesnake* is built of steel, and is intended to be attached to a fleet for protection against the attack of hostile torpedo boats. She is fitted with engines of 2,700 horse-power—exceptionally powerful for a craft of her size—and it is estimated that she will be able to steam at the rate of 19 knots per hour in a rough sea, which is faster than any torpedo boats can travel under like conditions. She will be fitted with three 14 inch torpedo tubes for discharging Whitehead torpedoes—one forward and one on either side. She is also to be provided with a powerful electric projector, which will be fitted on a bridge abaft the 4 inch gun. There are three vessels of this type—the *Grasshopper*, *Spider*, and *Sandfly*—in course of construction in the Royal yards; but their engines and machinery will not be ordered until after the *Rattlesnake* has had her official steam trials.

Luxurious Hairdressing.—The *City Press* states that the new hairdressing saloon about to be opened by Mr. Bigwood, at 26, Queen Victoria Street, will be one of the most spacious and complete of anything of its kind, and fitted up throughout in a really sumptuous style. The lighting and ventilation are perfect. One hundred incandescent lamps and a large arc lamp are supplied by a 12 horse-power "Otto" gas engine. A telephone and exchange company's tape are also among the provisions for the convenience of customers.

New Cable Manufactory.—The development of electric lighting and electric transmission of energy in Italy has given an impetus to the firm of Pirelli & Co., of Milan, who were originally manufacturers of India-rubber goods, but who have now taken in hand the manufacture of electric wires and cables of all descriptions. In order to meet the demand for these goods, the firm, *Industries* states, is erecting a branch works at Spezzia, where the manufacture of submarine cables will form one of their specialities. They have taken over a contract from the Government to keep in repair all the short submarine lines which connect the islands in the Tyrrhenian Sea, and it is expected that the new works will be started before the end of this year.

The Telegraph in China.—It is announced that his Excellency Liu-ming Chuen has contracted with Messrs. Telge & Co. for the construction of a telegraph line from Tai-nan to Tai-pei. Messrs. Jardine, Matheson & Co. have obtained a contract for laying a cable from Amoy to Hoo-mee (Formosa), the cost of which is estimated at $210,000. It is expected that both of these lines will be completed before the end of this year.

The Consolidated Telephone Construction Company.—We are requested to state that the company referred to as defunct in our issue of the 15th inst., is not the "Consolidated" Telephone Construction and Maintenance Company, which continues its operations as heretofore, but an older company with a similar name which never did any actual business.

Restoration of the Scilly Cable.—The Government telegraph steamer *Monarch* on Friday morning completed the repairs to the Scilly Island cable, thus restoring communication with the mainland.

Madagascar Cable.—The Portuguese Government has granted landing rights at Mozambique for a cable which it is proposed to lay from that point to Tamatave Diego Suarez, both in Madagascar and the French Island of Reunion. These cables will be laid under a French Government guarantee or subsidy. Proposals have been laid before the French Minister of Posts and Telegraphs by French and English contractors, but it is probable that the work will be entrusted to one of the French companies, as the Government is most anxious to encourage French industry, and desires that work of this class be carried on in France.

Atlantic Cable Traffic.—There is a strong rumour afloat that the Commercial Cable Company and the pooled Atlantic lines have arranged that the rate for messages between Britain and the States shall not be reduced below 1s. per word. This rumour appears well-founded, and within the last ten days has raised considerably the price of Anglo stocks.

The Marchant Engine.—We have received a very important letter from Mr. James Fraser on the Marchant engine. We regret that owing to the late hour of its arrival we cannot find room for it in our present issue, but it will appear in our next.

Lecture on Magnets and Electro-Magnets.—Prof. Silvanus P. Thompson, D.Sc., delivered one of a series of free popular Saturday evening lectures last week, under the auspices of the City and Guilds of London Institute for the Advancement of Technical Education, at the Finsbury Technical College, the subject selected being "Magnets and Electro-Magnets." The Lord Mayor presided. The lecturer dealt with his subject in the thorough and yet popular manner which might have been expected, and was listened to with great interest. At the close of the lecture, the Lord Mayor, in proposing a hearty vote of thanks to Prof. Thompson, said it was to be desired that men engaged in trade round about that locality should derive benefit from the institute provided by the liberality of the Corporation and the livery companies. It was of no use to establish these institutions unless they were well supported, first, by those who had the money, and, secondly, by those who could derive advantage from them.

The Electric Light and the Eyes.—*Science* states that an examination, by an oculist, of the eyes of 1,100 persons who work by the incandescent electric light, fails to show any injurious effects produced by that light. The arc-light may cause eye trouble if in too close proximity.

The New York Underground Work.—We give in our leader of the present issue some remarks of Dr. Chisholm, of the Thomson-Houston Illuminating Company of Chicago, with reference to the durability of the material to be used on this system. With these remarks we entirely agree. We believe the system to be a complete mistake and a radically faulty one. The method of jointing the blocks, we feel certain, will prove utterly unreliable, quite irrespective of the partially porous character of the material used. The depth at which the blocks are placed is one source of great danger to the system, for in very wet weather we have the pressure of a head of water equal to the depth of

the blocks below the ground level. We have on more than one occasion found that a system which has answered perfectly when submitted to the test of simple immersion in water, has failed utterly when buried in damp situations at a depth several feet below the ground surface, and the fault has been clearly traced to the cause mentioned, viz., the pressure of the head of water. We feel sure that a similar fate will overtake the New York underground system sooner or later, unless a greater means of protection from moisture is taken than is afforded by the means adopted.

Lectures at the Finsbury Technical College.—In reply to a correspondent we have to state that the lectures alluded to in a former issue constitute part of the ordinary curriculum of the college, and will not, therefore, be reported in our columns.

Trotter's Dioptric Glass.—In consequence of a misunderstanding which appears to prevail among the trade, Messrs. Goolden and Trotter ask us to state that, while the foreign agency of their dioptric glass (Trotter's patent) is in the hands of Messrs. Woodhouse and Rawson, the English trade remains in their own hands as heretofore,, there being no sole agency for Great Britain.

Electrical Distribution.—Messrs. Paris & Scott, whose system of electrical distribution we touched upon some two years ago, intend to show their apparatus in action at next year's Newcastle-on-Tyne Exhibition. It may be remembered that the Scott-Paris transformers consist of field magnets and armature, the latter being coiled with two separate conductors, one for high tension and the other for low tension currents, each having its own commutator. The fine wire coil receives current from any generating station, and turns the armature as a motor, while the thick wire acts, of course, as the conductor of an ordinary dynamo. It is expected that a conversion of 95 per cent. and a commercial efficiency of 90 per cent. will be obtained with these transformers. We have received a lengthy description of Messrs. Paris and Scott's system, but we think the action of their apparatus will be understood from the above and from that which we have previously stated.

The Gülcher Company.—We hear that this company is extremely busy, both in the arc lamp and dynamo departments, and on installation work. The lighting of Mr. G. E. Belliss's private house at King's Norton has just been placed with the company, the installation and work to be carried out to the specification of Mr. Henry Lea, of Birmingham. The plant will consist of an Otto gas engine and Gülcher dynamo, which is to charge 40 storage cells. The lamps throughout the house are to be fitted with special fittings, and in many cases Mr. Lea's patent pendant, which has attracted so much attention in Birmingham, is to be adopted. It is also intended to dispense with manual labour in the dairy, the churn being driven by an electro-motor. The company has also in hand an installation at Messrs. Beanland's mill at Huddersfield; the lighting of the Co-operative Stores, Newcastle; the Pontypool Iron and Tin Plate Company, Pontypool; and also a considerable extension in the lighting plant of the Coalbrookdale Company and several other contracts of less importance.

Callender's Conductors. The main cables used for wiring the Agricultural Hall at Kensington have been supplied by Callender's Bitumen Company, the conductors being of a heavy nature.

The Distribution of Power.—The article which we publish this week from the *Génie Civil* is of considerable importance, and our thanks are due to Mr. Serrin for bringing the matter before our notice. The Birmingham scheme, upon which that gentleman touched in our last issue, is a subject for a great demonstration of electrical possibilities.

The Siemens Dynamo.—We hear on very good authority that the new dynamos which Messrs. Siemens Bros., are supplying for the new Agricultural Hall at Kensington, will create some sensation amongst manufacturers. Up to the present the articles supplied by this firm have not been noted for low prices, but now we understand machines have been produced, which for workmanship, output, and low cost will prove serious rivals to all others in the market.

Patentees Please Note.—The commonly accepted doctrine of American patent law, says the *Scientific American*, is that no person has the right to make, use, or sell a patented invention without the consent of the patentee; whoever does so is liable as an infringer, and the court, on due proceedings, will enjoin him from the use. But in the case of Hoe & Co., the well-known printing-press makers, against Knap, tried in the United States Court, northern district of Illinois, Judge Blodget declined to enforce the above doctrine, holding as follows:—The proof on the application for a preliminary injunction was to the effect that the complainant, the owner of this patent, had never used it, and never constructed a printing press with the Crowell device. The argument is that the owner of this patent was a very large manufacturer of printing presses; that they did not manufacture and keep printing presses in stock, but only made them to order; and that they have received no order as yet to make a press containing the Crowell device. The question, therefore, arises whether the court will grant an injunction in favour of the owner of a patent who has not, after a reasonable time, put it into use, against another who is using it. I think, under a patent which gives a patentee a monopoly, he is bound either to use the patent himself or allow others to use it on reasonable or equitable terms, and as I refused an injunction on the motion before the hearing, I shall refuse an injunction in the interlocutory degree, and allow the defendants to continue to use the patent on their giving bond as they have heretofore.

The Electric Launch "Volta."—On Saturday, at the instance of Major-General Fred. Brine, a further trial of the capabilities of the electric launch, the *Volta*, was made on the lower reaches of the Thames in the presence of General Lord Chelmsford and other officers of both branches of the service. Those present included General Pritchard, General Sir R. Pollock, General Sir H. de Bathe, Admiral Sir Erasmus Ommanney, Admiral Curme, Captain Palliser, and Captain Murphy. The trip was from Westminster Bridge to Greenwich Hospital, where the party were entertained by Admiral Brandreth. Complete satisfaction was expressed by all present with the speed attained, averaging something over six miles and a half per hour. Next year, we understand, it is the intention of the firm to whom the *Volta* belongs to put other electric launches on the upper Thames for pleasure purposes.

Good Electric Light Cable Joints.—With the intention of doing away with the difficulty and danger arising from badly made joints in electric light cables, Messrs. Walter T. Glover & Co., Salford, Manchester, have brought out a plan of jointing various sizes of cables before putting on the insulation, thus giving an equal insulation throughout the entire length of a circuit, at the same time doing away with bulky and unsightly joints. Thus a cable is made of, say, 19 10, 19 14, and 19 18, all jointed in the core before being insulated. This appears to be an excellent idea, and doubtless engineers will take advantage of it in special cases.

To Investigators.—To those of our readers who feel inclined to compete for the Volta prize, we think that one direction in which success might be assured is in connection with railway signalling. In France the systems employed are not nearly so perfect as those on our English railways.

The Glow Lamp Monopoly in Germany.—The various law suits which have been going on for some time in Germany between the owners of the Swan and Edison patents for glow lamps, are not likely to come to an end just at present, the Berlin correspondent of *Industries* states. The latest phase of this question is a meeting which was called for the 18th inst., by the three firms most interested in the prevention of an Edison monopoly, viz., Messrs. Naglo Bros., Messrs. Spieker & Co., and Messrs. C. & F. Fein. These firms have addressed a circular letter to the trade, inviting the co-operation of those interested in the development of electric lighting, and a condensed summary of the various legal decisions accompanies the invitations.

An Electric Boat.—Trials have been made on the Spree at Berlin with the *Electra*, belonging to Messrs. Siemens and Halske, in presence of a number of prominent engineers. The boat is propelled in the usual way by a storage battery and electric motor, working a screw of peculiar construction, and, as far as can be judged from the short trial just made, has proved a success.

Electric Roads in New York.—It is stated that the Third Avenue Street Railroad Company, of New York, contemplates the use of electricity on its lines. The president of the company visited Baltimore recently to witness the working of the line there.

"Electricity as Applied to Railroads."—Mr. G. W. Mansfield, of the Daft Company, was to speak on this subject last Wednesday before the electrical section of the American Institute.

High Praise for Motors.—The users of Sprague motors in Boston, are quite enthusiastic in their praise. A merchant tailor, states the *Electrical World*, says: "I am more than pleased with the motor." The superintendent of the Bay State Cash Railway Company says: "It is the best and cheapest motor power I ever used." C. H. Farmer & Co., manufacturers of braid, say: "It works better than steam with us, and we think it the best power for a small manufacturer." De L. Sheplie & Co., makers of straw goods, say: "We consider the motor a great benefit to us, in furnishing us with a uniform power."

The Grosvenor Gallery.—The Ferranti transformers at the Grosvenor Gallery are said to act very satisfactorily. This is welcome news, and we hope nothing will occur to occasion any further changes in the *régime* of the place.

Expected Fusion of Companies.—It seems to be quite within the bounds of possibility that a combination will be entered into between two well-known electrical companies, as we are informed that the leading personage in both is very desirous of a fusion.

The Paris Exhibition of 1889.—To assist the Director-General of the proposed Universal Exhibition of 1889, a technical committee for electricity has been formed, and amongst the names we notice those of MM. Becquerel, Deprez, Mascart, Blavier, Carpentier, Fontaine, Hospitalier, Joubert, Mercadier, De Meritens, Planté, Baron Edmond de Rothschild, Vivarez, Napoli, Sartiaux and others.

The Callender-Webber Conduit.—We have this week seen the experimental conduit laid down in the old works of the Brush Company, under the plans of Mr. T. O. Callender and Major-Gen. Webber. It appears to answer the purpose for which it is devised, although it would not be wise to call it perfect until the lapse of time brings with it conviction. As it is intended to exhibit the system publicly, those of our readers who feel interested in the safety of underground conductors will have opportunities for studying its details for themselves.

Trial of Engine made by Messrs. Davey, Paxman & Co.—On Wednesday last an interesting trial was made at the Indian and Colonial Exhibition of one of Messrs. Davey, Paxman & Co.'s engines, which has been in use for electric lighting purposes for three consecutive seasons. The engine under test is of the semi-fixed compound type of 40 H.P. nominal, the boiler being above the engine, and made of steel, after the locomotive pattern, with 100 iron tubes. During the whole time allotted to the experiments the external work of the engine was utilised in charging over 200 secondary batteries—in fact, it was simply doing its customary work. The gentlemen superintending the arrangements were Mr. W. E. Rich, C.E. (a partner in the firm of Easton & Anderson, of Erith, who have carried out so successfully the trials of engines for the Royal Agricultural Society of England), and Professor A. B. W. Kennedy, University College, London, whose names are a sufficient guarantee for the fairness and correctness of their report. The greatest care was paid to the consumption of coal and feed water evaporated, the readings being observed on the completion of each 100 lbs. of coal fired; indicator diagrams were obtained from each end of the cylinders, and the revolutions of the crank shaft were taken on a Harding's counter, giving the total number of revolutions during the run. The commencement of the trial began at 10.12 a.m., and lasted for 5 hours 42 minutes, the results shown being remarkably economical for a high-pressure non-condensing engine with cold water feed. We cannot give full particulars this week, Mr. Rich preferring to issue the figures and curves in a perfect state; but generally, we may state that the engine indicated 111 H.P., with steam at 107 lbs. pressure, the expenditure of coal being 2·53 lbs. per H.P., evaporating 23·82 lbs. of water, at a temperature of 55° Fahr., and the revolutions numbering about 104 per minute. We regret that in consequence of some hitch with the lighting committee of the Exhibition, no facilities were granted for making electrical tests of the external work.

Manchester Royal Jubilee Exhibition.—Applications for space must be sent in before November 1st. Mr. Samuel Lee Bapty, who is appointed general manager, in taking leave of his friends at the Liverpool Exhibition, and accepting from them a handsome testimonial, mentioned that it had been intimated to him that in connection with his new sphere of labour no presentations are to be allowed. Probably no one will so fully realise the wisdom of this step as Mr. Bapty himself.

Edinburgh Exhibition.—A list of awards was published on Tuesday morning, but the juries of the "Prime Movers" section and the "Electrical" have not yet reported.

The Melting Platinum Standard of Light.—We are once again indebted to the courtesy of Prof. Chas. R. Cross for advance proofs of an article which was read at the American Academy of Arts and Sciences. The subject is the "Melting Platinum Standard of Light," and we print the article in another part of the present issue.

An Electrical Rivetting Machine.—We are informed that a rivetting machine for ship work, the design of Mr. F. J. Rowan, has been given a trial in McMillan's Yard, Dumbarton.

Personal.—We understand that Mr. W. A. Bryson, the electrician to the Edinburgh Exhibition, has been appointed to a similar post in connection with the Manchester Jubilee Exhibition.

We learn that M. Faure who is so well known in connection with secondary batteries, has proceeded to America, where he has accepted a very lucrative position with an American Company.

Removal.—Messrs. Webster, Horsfall and Lean, of Birmingham, have removed their offices to Aitken Chambers, corner of Cannon Street and New Street.

NEW COMPANY REGISTERED.

Portuguese Hydrogen-Amalgam Company, Limited.—Capital, £6,000 in £1 shares. Objects: To acquire from the Hydrogen-Amalgam Company, Limited, an exclusive license for Portugal of an invention relating to improvements in amalgamating gold, and for an apparatus employed therein. Also to purchase and sell chemical and electrical properties and inventions. Signatories (with one share each); Alex. Brogden, J.P., 9, Victoria Chambers, S.W.; H. Brogden, Altrincham, Cheshire; G. A. Ollard, Greenhithe; T. W. Binyon, 15, Bedford Row; E. Horton, Darlaston; R. Baker, 24 and 26, Basinghall Street; F. Burrows, 34, Garfield Road, Lavender Hill. Registered without articles of association on the 22nd inst. by Messrs. Smiles, Binyon, and Ollard, 16, Bedford Row.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hydrogen Amalgam Company, Limited.—The statutory return of this company, made up to the 2nd ult., was filed on the 20th ult. The nominal capital is £200,000 in £1 shares, the whole of which are allotted. Seven shares have been paid up in full, and the remaining 199,993 shares are considered as paid up. Registered office, 23, Cross Street, Finsbury.

River Plate Telephone and Electric Light Company, Limited.—An agreement, dated 19th inst., between this company and Mr. Wm. Cuthbert Quilter, provides for the allotment to the latter of 5,000 fully paid up £5 shares, bearing a cumulative preferential dividend of 9 per cent. per annum, in consideration of his paying the company the sum of £20,000 forthwith.

Sir Coutts Lindsay & Company, Limited.—In accordance with the Companies Act, 1862, a resolution was passed by this company on the 14th inst. increasing the nominal capital of this company by the addition thereto of £70,000. The total registered nominal capital now stands at £100,000 in £1 shares.

Self-Propelling Motor Syndicate, Limited.—A resolution was passed at a meeting of this company on the 14th inst. authorising the increase of the nominal capital by the addition thereto of £5,000 in £5 shares beyond the registered capital of £20,000. The resolution was registered on the 20th inst.

CITY NOTES, REPORTS, MEETINGS, &c.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.

THE twenty-sixth ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Wednesday, Mr. John Pender presiding.

Mr. F. E. Hesse, secretary, having read the notice convening the meeting, and the report (which was printed in the REVIEW last week) having been taken as read,

The Chairman, in moving its adoption, said the gross receipts for the half year amounted to £224,843 against £259,476 for the corresponding period of 1885, showing a decrease of £34,633. This loss of revenue was, in some measure, attributable to the general depression of trade, but it was chiefly owing to the absence of any stirring incident, such as those which were of continual occurrence last year. They had been urged on all sides to lower their tariffs, which were alleged to be prohibitive; but they did not see their way to reduce them to the extent that was desired. They had yielded to the wishes of the Australian representatives, encouraged by the growth of traffic, which, as regarded Australia, had for some years past shown an annual increase of over 10 per cent. It was a singular circumstance that within a few months of the conference at Berlin and the reduction on the tariff, the traffic had begun to show a falling off, which had continued ever since. The decrease for the half year under review was over the whole of their system. This was rather a gloomy statement, but, as he had often said, telegraphy was greatly influenced by trade. There was now a very great change going on in trade, even in the City of London. They were talking of "booms"; and he expected that they would begin to see benefit from the excitement before very long. In Australia, during six months, the revenue showed a loss, simply on trade messages, of £13,000; Java showed a loss of £2,500; Tonquin, China, and Siam, £5,200; China and Japan, £5,000; local traffic, £2,200; the New Zealand subsidy, which ended last year, £2,700; while the loss by exchange (which was the silver question now engaging a good deal of attention) had been no less than £4,000. These sums together made a total of £34,600. But there was nothing in them which might not be materially altered when he had the pleasure of addressing them six months hence. Unfortunately, however, since the close of the half-year, the traffic had shown a proportionately larger decrease than during the six months—making things still worse to the amount of £30,000 in the three months ending September. Only a portion of the loss was attributable to the reduction of the tariff, which came into force on July 1st, and the reduction of the number of messages had been unfortunately aggravated by a misfortune to both the India and Penang cables, which had been interrupted for the first time since that portion of their system was duplicated nine years ago. He was pleased to state that as far as Australia was concerned, there had been last quarter a small increase in the number of words transmitted on the corresponding months of 1885, which was slightly lessened through the loss occasioned by the reduction of tariff. In regard to China, Tonquin and Cochin China, there not only appeared a loss resulting from the reduction of tariff but from the falling off in traffic. The working expenses for the year had amounted to £81,775, against £74,418 for the corresponding period of 1885, showing an increase of £7,357. This increase was practically accounted for by their having had an additional maintenance ship as compared with 1885. This expense, however, would be saved during the current half-year, the screw-steamer *Agnes* having been sold by public auction in July last. The dividend would be as usual. An interim dividend at the rate of 5 per cent. per annum had been paid for the half-year, but in consequence of the decrease of revenue the directors had thought it prudent not to pay any bonus, but to carry forward the whole balance of £34,980 to the current half-year. If the increase during the current half-year admitted of the bonus being distributed, it might be dealt with at the end of the year, or six months hence. The policy of strengthening the company's system had been continued by the renewal in June last of the Singapore-Penang original cable. The maintenance ships had been kept busily employed during the greater part of the half-year effecting numerous small repairs, but no interruption of any importance to traffic had occurred until after the close of the six months, when the India and Penang cables were interrupted. Fortunately they had both been repaired after thirteen days' interruption notwithstanding that the south-west monsoon was prevailing at the time, and both cables were now in good working order. The China system had been materially strengthened since he last addressed them. He had gone to Copenhagen to meet the directors of the Great Northern Telegraph Company, and the result of his visit had been to place their relations with the Great Northern Company on a most satisfactory footing. These relations would continue for a very long period of time, and so far as he could judge would be very beneficial for both companies, leading probably to lower rates, certainly to considerable economies in the working of the two systems. He had now to refer to the negotiations with the New Zealand Government. At the beginning of this year the subsidies which they had from the New Zealand and the New South Wales Governments came to an end. The New Zealand Government objected to a renewal for 10 years, and the question having been brought before the Parliament of the country it was agreed to renew it for five years. The company had found that during the 10 years, after putting aside the amortisation, the cable had not yielded more than 2 per cent. for their money. He had therefore held that they were entitled to a renewal for the full period; however, looking at it in connnection with a larger question which they hoped eventually to see carried out in the Australian colonies, they agreed to accept a five years' renewal. The negotiations had been conducted with a gentleman very well known in London and all over the colonies, Sir Julius Vogel, the head of the Government. They had endeavoured to conciliate the Government in every possible way, until the company were now driven into this position. The Government had declined the five years' renewal and they had declined arbitration, the reason they gave being that they thought the subsidy would interfere with the laying of an opposition cable. He did not think there was any possibility of a cable being laid in opposition to them, for the simple reason that he did not think the colonies—more particularly New Zealand—had much money to throw away. He doubted whether the people of New Zealand would approve the expenditure of money on an opposition cable when they could get from the present company cheaper and more efficient telegraphy than could possibly be produced by an opposition cable. Taking the figures of the proposed opposition and the subsidies it expected to get, it would cost Victoria £35,680 a year, while the company's proposition, giving the same tariff as the opposition, would cost the colony £16,000. The cost of the opposition cable to New South Wales would be £34,000, of the Eastern Extension £15,000; to South Australia, opposition £11,000, Eastern Extension £5,000; to New Zealand, opposition £20,000, Eastern Extension £9,000; Queensland £11,000 against £5,000; Australia £4,000 against £2,000. When they remembered that the present company did its work well,

and that it would have a duplicated against a single system, he thought all reasonable men would agree that it was simply impossible that opposition could be brought about. But he would go a little further, and say that if the subsidy of £100,000, which the opposition company desired to have, were granted to the Eastern Extension Company, they would give a tariff of 2s. 6d., instead of 4s., which was the tariff of the proposed opposition. That would be an extraordinary alteration in Australian traffic—a message carried to Australia for 2s. 6d.! They were prepared to do that if they were granted the terms which this opposition company desired, and he thought they could beat any competition, no matter from what quarter it came. Sir Julius Vogel had that morning, after a week's delay, declined arbitration, not seeing the necessity for it. On Monday next they would put up their rates between Sydney and New Zealand from 6s. to 10s., and show that after having by their private enterprise done so much for the colony, they were not going to be trodden upon in the way attempted. It had been suggested that this being the great race week in Australia, the change should be made at once, in order to draw public opinion in New Zealand to the question. But they had declined any such sharp practice, but on Monday next, after the public had enjoyed this holiday, they would put up the rates, and they would remain up until they got such a satisfactory arrangement as a company of such importance as theirs was entitled to at the hands, not only of the Government of New Zealand, but every Government with with which they had dealings. He concluded by moving the adoption of the report and accounts.

The Marquis of Tweeddale seconded the resolution.

Mr. Guesdon, as an old colonist, said the people in Australia were far too sensible to support any such scheme as that proposed in opposition to the Eastern Extension system. He proceeded to criticise the balance sheet of the company, drawing attention to the great increase in office expenses and rent of offices, which had nearly doubled since the change of offices. He also deprecated the sending out of stamped proxies containing the directors' names; and, further, urged that the board should be reduced to five directors, with a remuneration of £2,000 per annum.

Mr. Wm. Griffiths, whilst agreeing that it was advisable that every possible economy should be effected, thought at this period the directors should be left unfettered, and that the shareholders should support them heartily in their spirited policy against the recalcitrant colonists.

The Chairman, in replying to the remarks of Mr. Guesdon, explained that the cause of the largely increased office expenses was the rapid growth of the company, which necessitated a larger staff of clerks and more accommodation than their old offices afforded. With regard to the proxies, these were sent out at the expense of the directors; as to whether the names of the latter should or should not be printed upon them, that was a matter of opinion, and his opinion was that of the 5,000 shareholders, the 4,900 who were not able to attend the meeting should have some protection from the 100 who did attend.

The resolution was carried, and a vote of thanks to the chairman terminated the meeting.

The Brazilian Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ended 30th June states that the revenue for this period amounted to £75,856 10s. 10d. and the working expenses to £12,695 5s. 4d. After providing £9,680 for debenture interest and sinking fund, and £1,430 7s. 4d. for income tax, there remains a balance of £52,050 18s. 2d.; to this is added £2,123 16s. 4d. brought forward from 31st December last, making a total of £54,174 14s. 6d. A quarterly interim dividend amounting to £19,500 has been paid, and £13,000 transferred to the reserve fund, leaving a balance of £21,674 14s. 6d.

The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total payment of six per cent. for the year ended 30th June, 1886, and that the balance £2,174 14s. 6d. be carried forward to the next account.

Since the last general meeting the African Direct Telegraph Company have completed their system of cables between this company's station at St. Vincent and the British possessions on the West Coast of Africa, viz.:—Bathurst, Sierra Leone, Accra, Lagos, Brass and Bonny; the traffic from these lines will pass over this company's cables between St. Vincent and Lisbon.

The subscription by this company of £75,000, being one-third of the share capital of the African Direct Telegraph Company, authorised by the extraordinary general meeting held 21st January last, has been effected by a second issue of 5 per cent. debentures, at the price of £105 per £100.

The various sections of the company's lines are in good working order.

Telephone Company of Austria, Limited.—An interim dividend at the rate of six per cent. per annum up to September 30th has been declared on the preference shares of this company.

The West India and Panama Telegraph Company, Limited.—It has been decided by the directors to place £7,000 to reserve, and to recommend to the shareholders at the approaching meeting a dividend of 8s. per share on account of arrears of dividend on the first preference shares.

The Eastern Extension, Australasia and China Telegraph Company, Limited.—This company notifies that the coupon on their Five per Cent. Manilla Debentures (1880 issue), due on November 1st prox., will be payable on and after that date on presentation of the same at the Consolidated Bank, 52, Threadneedle Street, E.C. Coupons should be left three clear days for examination.

The Telegraph Construction and Maintenance Company, Limited.—This company notifies that the 23rd distribution on the certificates issued under the trust deed of March 12th, 1875, will be made on and after November 1st next. The distribution, which arises from dividends on the shares held by the trustees, will be at the rate of 9d. per £5 certificate, payable two clear days after presentation of coupon No. 23, at Messrs. Barclay, Bevan & Co.'s Bank, 54, Lombard Street, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 22nd were £2,975 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending October 22nd amounted to £3,616.

NEW PATENTS—1886.

13407. "Controlling the potential on circuits where alternating currents are used." J. M. V. KENT, W. H. SNELL. Dated October 20. (*Complete.*)

13423. "Portable telephone for short circuits on board ships, public buildings and general domestic use." H. BINKO. Dated October 21.

13449. "Conductors for armatures of dynamo machines." W. H. SCOTT, E. A. PARIS. Dated October 21.

13454. "Cap or cover for the ends of the revolving armatures of dynamo-electric machines." J. ROPER. Dated October 21. (*Complete.*)

13459. "Regulating automatically the intensity of the currents in dynamo-electric machines." H. J. HADDAN. (Communicated by F. Vivo y Graells.) Dated October 21. (*Complete.*)

13471. "Electrical machines for automatic contact, making and breaking and registering strength of current." A. BENINGHAM, M. JUSTIN. Dated October 21. (*Complete.*)

13475. "Arc lamps." W. ROWBOTHAM, F. S. WORSLEY. Dated October 22.

13507. "Suspension conductor for incandescent electric lamps." A. L. FYFE. Dated October 22.

13515. "Charging accumulators." E. J. HOUGHTON. Dated October 22.

13519. "Telegraph cables; making same." G. F. REDFERN. (Communicated by E. Gellerat.) Dated October 22.

13529. "Filling and emptying the cells of batteries." R. OAKLEY. Dated October 22.

13544. "Applying electricity to the actions of pianofortes." C. W. SIDDLE. Dated October 23.

13563. "Electrical measuring instruments." E. W. LANCASTER. Dated October 23.

13569. "Telephonic apparatus." J. S. ROSS. Dated October 23.

13587. "Electric measuring and regulating apparatus." F. L. RAWSON, C. W. S. CRAWLEY. Dated October 23.

13591. "Preventing escape of noxious fumes from batteries used for electrical purposes." M. BAILEY, J. WARNER. Dated October 23.

13592. "Primary batteries." M. BAILEY, J. WARNER. Dated October 23.

13631. "Igniting gas by electricity." H. J. COATES, E. W. J. MACDONALD. Dated October 25.

13641. "Indicating and regulating the electric potential in systems of electrical distribution." B. J. B. MILLS. (Communicated by J. W. Howell.) Dated October 25.

13648. "Making carbons for electrical and other purposes." W. R. JOHNSTON. Dated October 25.

13660. "Combination electrical switch." Sir D. L. SALOMONS, O. E. WOODHOUSE, F. L. RAWSON. Dated October 25.

13663. "Supporting, mounting, connecting, and gearing dynamo-electric motors; partly applicable to other apparatus." F. WYNNE. Dated October 26.

13665. "Producing electricity for lighting, motive power, &c." G. L. QUARRIE. Dated October 26.

13712. "Dynamo-electric machines." A. M. CLARK. (Communicated by Electrotechnische Fabrik Cannstatt.) Dated October 26.

13741. "Mechanical telephone apparatus." H. H. LAKE. (Communicated by M. G. Farmer.) Dated October 26. (*Complete.*)

13761. "Constructing and regulating electric arc lamps." W. ROWBOTHAM, F. S. WORSLEY. Dated October 27.

13790. "Electric light switches." G. BINSWANGER, H. HIRSCH. Dated October 27.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

14354. "Improvements in the electric lighting of railway trains." A. M. CLARK. (Communicated from abroad by the Electrotechnische Fabrik Cannstatt, of Cannstatt, Germany.) Dated November 23. 4d. Claims:—1. In the electric lighting of railway trains, the employment of two, or more, series of accumulators in such manner that one or more are being charged by the dynamo machine driven by the wheel axle, whilst the lamps are worked by means of other series of accumulators and conversely as specified. 2. Obtaining a constant current either by means of solenoids with cores, or by electro-magnets, or partly by means of a centrifugal regulator, in the manner specified, from a dynamo machine having a variable velocity.

14612. "An improved galvanic battery." A. DUN and F. HASSLACHER. Dated November 27. 6d. Claim:—In galvanic elements, the use of caustic potash or soda lye in combination with a permanganate or manganate for the electrolytic liquid, together with carbon, platinum, or any other negative electrode not soluble in the lye and zinc, or any other positive electrode soluble in the lye when the circuit is closed.

CORRESPONDENCE.

The Pollak Battery.

In your last notice on the Pollak battery you expressed a dislike of the term "self-charging battery" which I gave to this form of element. Allow me, therefore, to explain to you the reason for my adopting this designation. Any battery requires to be charged by two materials, either in a liquid or solid form, the one being the exciting fluid and the other the depolariser. The latter is supplied by the action of the Pollak battery itself; the former, of course, has to be renewed mechanically when exhausted. Therefore the Pollak battery certainly charges itself as regards the depolariser, and I do not think that the name is a misnomer, or that it would mislead anyone acquainted with the nature of primary batteries.

As regards your anxiety whether the zinc would not be attacked by copper, I beg to say that my experience has taught me that this is not the case. The preventive which Mr. Pollak has employed for this purpose is such as to make this fear baseless. I may say that the cells which have now been at work in my warehouse for three months show no signs of exhaustion nor any diminution of E.M.F. The zincs which I have taken out of some of the cells show no signs of any deposit of copper, and have lost considerably less weight than I expected, judging from the work performed.

G. Binswanger.

October 27th, 1886.

Simple Make and Break.

I am sorry to trouble you again, but I think I made a mistake in the translation of Mr. Snyer's letter (published in the number of the 15th inst.); instead of " . . . . I abandon willingly the welded tube, its many *applications*, &c.," I ought to have written: " . . . . I abandon willingly the welded tube, its many *manipulations* . . . . "

Could you kindly correct this by mentioning it in your next number.

B. Bachmeyer.

The Electric Locomotive and Power Company, Limited.

If the advantages claimed by my patent are anticipated and fully described in Mr. Radcliffe Ward's patent of January 31st, 1883, as stated in Mr. R. W.'s letter appearing in your last issue, it is open for him to commence proceedings against my company. Mr. R. W. has been invited to take this step, but has not accepted the invitation.

It is somewhat ridiculous to observe that whilst Mr. R. W. alleges an infringement, he is so anxious (*vide* paragraph 4 of his letter) to disclaim, and wishes the reader to understand that his system is entirely different to mine.

C. P. Elieson.

October 27th, 1886.

[Discussions on matters which are more suited to Courts of Law than to our columns, had better be avoided when possible.—EDS. ELEC. REV.]

Commercial Efficiency of Dynamos.

Mr. Trotter has forwarded us the following copy of a letter which he has written to *Industries* respecting the article which we, in another column, reproduce from that journal:—

[COPY.]

26th October, 1886.

To the Editor of "Industries."

Sir—In your very flattering article on "the commercial efficiency of dynamo machines," you state that the method was devised by me.

It is entirely due to Mr. H. W. Ravenshaw, to whom it was suggested by Captain Cardew's method of using two dynamos, in which, however, the efficiency of the motor is assumed or else measured by a mechanical dynamometer.

While the credit of commercial inventions is often absorbed by the firm by whom they are first brought out, I think it is important that purely scientific discoveries should be credited to the actual inventor.

It should be remarked, that the tests which you give were carried out more for the purpose of ascertaining the difference between electrical efficiency and commercial efficiency, than for determining the actual commercial efficiency of the machine in question; moreover, the efficiencies were taken not at the greatest output only, but at various outputs, thus giving the *average* efficiency for different loads.

The result shows that for this size of machine—namely, a 7½ unit, the difference between the two efficiencies is only 3½ per cent.

The electrical efficiency can be determined in one's arm-chair; and for any machine with a given type of dynamo one can determine the commercial efficiency with accuracy sufficient for practical purposes when this difference is known.

I hope shortly to investigate the relative efficiency of a machine when used as a dynamo and as a motor, in order to settle what you describe as a weak point in the method, and this I propose to do by using a machine whose name had better be withheld, which has an electrical efficiency of 49 per cent., and the commercial efficiency will probably turn out to be 30 per cent. The losses being so great it is probable that when carefully tested, both as dynamo and as motor, if any practical difference exists it will be easily detected. The other two machines will be of good efficiency though of small size.

At the same time I would point out, that as far as the former tests were carried, even in the inferior machines, there was practically no difference in the combined efficiencies as motor and as generator.

Yours faithfully,

ALEX. P. TROTTER.

Incandescent Lamp Patents.

Knowing that additional legal proceedings, if commenced just now, may tend to frustrate the advancement of the electric lighting industry, and, if publicly announced in the papers, would do harm to many, I have under these circumstances written the undermentioned letter to Messrs. Crossley and Hicks' solicitors, which fully explains my views, and by which the trade will clearly see that I am anxious to avoid further law proceedings if possible. But, of course, if compelled to do so I must take such a step, especially as this particular claim is one of the means of breaking the chain of the threatened monopoly, because lamps of any resistance can be used made on this principle.

Arthur Shippey.

26th October, 1886.

[COPY.]

Gentlemen—I have perused your letter in the last issue of the ELECTRICAL REVIEW with considerable astonishment. "Facts are facts"—and what I stated in my communication to the Editor, I shall be able to prove in a court of law; and I again repeat that your clients' presumed invention has been anticipated by me, as the improved bulbs for the same object, as described by them, are clearly shown and described in my specification, No. 5,955, 1883. And further, had not your clients covered their

presumed improvements under the misleading title of "Improvements in Incandescent Lamps" instead of "Improvements in Lamp Bulbs," which is the subject matter of their specification, and a misnomer of facts, as clearly shown by the only claim which your clients have attempted to make, and had I known the nature of their claim earlier, I should most certainly have instructed my solicitors to oppose the granting of the great seal by the Patent Office in the usual way.

On behalf of my firm, and those interested with me in this patent, as well as for the trade, I wish your clients to distinctly understand that I mean to uphold this part of my patent, as it is one for an incandescent electric lamp globe, "not made entirely of clear glass," and is the first patent filed in England or abroad describing this special class of lamp, and so satisfied am I as to the validity of this particular claim, which is duly specified in my patent, that I am quite willing to allow it to be adjudicated upon by, say, six of the leading firms or experts connected with the trade, three to be appointed by your clients and three by myself, and shall be content to be bound by the decision of the majority upon this point, the condition being that those against whom the verdict is given should pay five guineas to each of the six gentlemen appointed as arbitrators, whose decision shall be final and binding upon us both.

I mention this mode as an economical way of settling the question in dispute, instead of incurring the costs of a trial in the Chancery Court, which amount would, in all probability, have to be paid by your clients.

It must be clearly understood that this offer is made by me without prejudice to our legal rights, and this to hold good for our work only from this date; and if your clients are not prepared to accept these proposals, which are made in the interest of the trade generally, please say if you are prepared to accept service of an action for infringement, which I will instruct my solicitors to forthwith commence against them, in order to protect the patent rights claimed by,

Yours faithfully,

ARTHUR SHIPPEY.

To Messrs. James and James, Solicitors,
23, Ely Place, E.C.

The Marchant Engine.

The managing director of the Marchant Syndicate has addressed a letter to one of your contemporaries, in which he mentions my name as one of the gentlemen who had spoken of the Marchant engine in favourable terms. I am quite certain that my letter in your issue of 24th September does not warrant this. In it I admitted that the subject was of deep interest, and in remarking on it I assumed that the fuel consumption was carefully checked, and that the brake H.P. was accurately measured. Mr. Reckenzaun's last letter, however, puts the matter in a different light. He states that as the flywheel pit was filled with water, the points, E and F, were hidden from view, and had to be described as they were described to him. At the time I wrote my first letter to you I considered the construction of the brake very carefully, and I saw no reason to find fault with its action, provided that the lower beam of the brake, when it is in action, is carried clear of, and does not touch, either of the supports, E and F. In your description of the apparatus you state that the stop, F, is placed so that when the pointer on the Salter's balance is at zero, there shall be no back play, by which I presume you mean slack in the chain. If this means anything at all, it means that the moment the flywheel commences to rotate in the direction of the arrow, the brake rotates with it sufficiently to obtain the desired pull on the spring, and in the act of so rotating with the centre of the flywheel as its own centre it must swing its lower beam clear of the point, F. The description of the rolling block, E, is not so clear; but as it is situated slightly to the scale side of a vertical line passing through the axle, it matters not how hard it is wedged up against the surface of the pulley, so long as the brake is out of action and the pointer at zero. The same action of rotation which lifts the beam from point F will also lift it from the point E, though, of course, in a lesser degree. Now, Sir, at the time I wrote my letter to you, I put the question to myself what effect these two apparent fulcra might have on the action of the brake, but after reading the paragraph on page 277, I came to the belief that the conductors of the trial had satisfied themselves that the lower brake block *was* clear of these two points, and Mr. Reckenzaun's last letter confirms me in this opinion. Of course, if those who conducted the trials are uncertain on this point, the whole value of the trials falls to the ground. A writer in this week's *Engineering* has given a very clear statement of the action when the point, F, becomes the fulcrum on which the brake turns, instead of turning, as it ought to do, with the flywheel as its centre.

R. E. Crompton.

October 26th, 1886.

[With respect to Mr. Crompton's last paragraph, we beg to refer our readers to p. 424.—EDS. ELEC. REV.]

Mr. Marchant sends us the following copy of a letter to *Engineering*, in reply to the article on the Marchant engine which appeared in that journal, and which is adverted to in another column :—

[COPY.]

To the Editors of "Engineering."
THE "MARCHANT ENGINE."

25th October, 1886.

Sirs,—You are good enough to *assume* the existence of certain facts in regard to the modification of the "Prony" brake, which, as stated in my letter to the ELECTRICAL REVIEW, I was led to adopt for convenience of space, and also good enough to argue on such *assumption* against the report of competent inspecting engineers who carefully examined the brake before using it.

Your inspection was equally invited to the means by which I return a steam feed to the boiler, and it is therefore no fault of mine that you now write on a false *assumption*.

I am now urging matters forward to the purpose of a further and more perfect exhibition, with a generally approved brake, when your inspection will again be invited.

In the meantime my answers to Mr. D. K. Clark, and to "Investor," and to further correspondents who may desire to stop my reaching the end of a long journey, will appear with my other communications to the Editors of the ELECTRICAL REVIEW, who have incurred considerable trouble and expense in bringing before engineers an invention which they believed would reduce the cost of electric lighting to one-third of its present prices, and which they accordingly investigated in the interests of those of their readers who are engaged in electric lighting pursuits.

Your obedient servant,

R. M. MARCHANT.

With your permission I will correct a few more of Mr. Marchant's mis-statements.

1. I never stated that I had wasted my time in the way he describes.

2. I *did* see the cards at the Inventories, and the worthless calculations based on them.

3. I have never made any "offer" to Mr. John H. Fraser, so Mr. Marchant is going rather out of his way to "decline" it.

4. I have not expressed an opinion *first* and enquired *afterwards*. It is more than 12 years since I heard Bidder and Halpin's views on this "new thing," and I always take care to have my information well up to date of writing.

It will be time enough to discuss *principles*, when the great question "How does he do it?" has been satisfactorily answered; but meanwhile I would advise Mr. Marchant, as I did four years ago, to see Mr. Macfarlane Gray, who knows more about "steam-feed" than half-a-dozen syndicates and their "competent engineers" all rolled into one.

Wm. H. Massey.

26th October, 1886.

So much has been said about the brake used by Mr. Marchant at the recent tests of this engine, and more especially about the stop, F, as shown in your diagram, page 277, September 17th, 1886, that I have deemed it advisable to make it a matter of personal examination, and I beg to say that when the engine is at work with a full load, the brake clears stop F by nearly two inches; this fact can be verified by anyone interested in the matter, and the assumption that stop F acts as a fulcrum is therefore erroneous.

William Downie, *Managing Director,*
THE MARCHANT ENGINE SYNDICATE, LIMITED.

It is my intention so far as possible to avoid controversy on what are really side issues to the necessary result of my one accomplished fact of effecting a *steam* feed to the boiler, but it appears necessary that I should refer to such remarkable practice as that the editors of *Engineering* should *assume* that the stop, F, in the brake diagram is a fulcrum on which the brake turns instead of the ordinary stop, and base their arguments principally on such assumption, whereas your representative, Mr. Margary, examined the position of such stop before using the brake, as did also Mr. Howard in his subsequent tests.

In your last issue I stated my reason for adopting the brake used, and as this brake has its opponents as well as its supporters, and as I only adopted this modification of the "Prony" brake for the reasons already stated, and as there would, I apprehend, be few who would assert that a weight of 720 lbs. clipped tightly on to a 7 feet fly-wheel of some 10 inches broad meant no absorption of power—I consider it my duty to meet the whole question by preparing a further and perfected exhibition and a generally approved brake.

"Mr. D. K. Clark," writing to *Engineering*, *assumes* the power of the engine limited to the mere cylinder power, ignoring any power from the use and expansion of the steam in the pumps. I may, therefore, inform this gentleman, that some years ago when I was blundering over ascertained and demonstrated facts, which I was *at that time* unable properly to explain to others, or consequently to handle properly myself, and which others could not explain to me, *although they recorded the facts*—and when the engine used was so arranged that it could be worked with a *water* feed to the boiler and the pumps detached, and again with the *steam* feed through the pumps to the boiler, the following result among others was recorded.

On the trial taken with the steam pumps in operation to the purpose of supplying the *steam* feed, the engine ran continuously at 200 revolutions per minute with a load on the Royal Agricultural Society's brake, then in use for the purpose; and on the trial taken with a *water* feed to the boiler, *and these pumps detached and isolated*, the engine would not *even carry* the same load *at the same boiler pressure*. This result astonished the engineers then testing the engine, and although the proper conclusion (which is now manifest), *that the pumps were additional cylinders to the engine*, was not then arrived at, I may refer to such result now, in answer to any such mode of treating the whole power of the engine as due to the cylinders only. No one knows better than one of the editors of *Engineering* that such result was expressed!

The difference between our action on such and other exhibited facts being, that he then witnessed results I was unable to explain to him, and that he left the results without further enquiry, taking up the position that "he did not believe in Mr. Marchant," which expression found, I assume, its further utterance in the editorial which I now refer to; whilst I persistently worked away, until in time I grew to comprehension of such apparently extraordinary action, and am now able to explain it to the comprehension of unprejudiced enquirers.

An inventor's life is one of peculiar trial. I have had eighteen years of such a life, with all my energies devoted to the bringing out of those results which the facts I proved led up to; and I submit to men of any professional feeling that mere "*assumption*" is scarcely the weapon with which my results should be assailed.

The trial of the "Marchant engine" at the International Inventions Exhibition, which is alluded to by "Investor" in *Engineering*, was certified to from the *indicated cards* then taken, and not from the brake power, and the gentlemen named by him certified on facts instead of arguing on assumptions.

In your own last issue, a gentleman signing himself "The Writer of the Article" in *Industries*, ignores *the one point* of the whole question, and I adopt his figures to the purpose of showing what a *steam* feed means.

He takes the heat developed by the combustion of 1 lb. of coal as equivalent to the performance of 10,171,576 foot-pounds of work; he then allows 80 per cent. of this, say 8,137,261 foot-pounds, as possibly attainable, and then asserts that *a perfect* engine will only utilise "23·2" per cent. of this latter amount.

I ask, *what perfect engine* will only give "23·2" per cent. out of the power he admits to be obtainable from the fuel, and after the 20 per cent. deduction for loss, which leaves the 80 per cent. we so deal with?

And the *necessary* answer is, *a water-feed* engine in which the 76·8 per cent. of *further* loss has to be allowed for the *latent heat loss* in the repeated and continuous manufacture of steam out of water!

Had this gentleman not made the error of dealing with the heat units which are *expended* for the boiler work, instead of dealing with the *sensible* heat units effected *in* the boiler, to which "Joule's equivalent," is more specially applicable, he must have arrived at a different conclusion, and would have recognised *where* the 76·8 per cent. of loss which he speaks of went, and *what* a *steam* feed to the boiler means.

This gentleman then *very strangely* complains that my process is not perfect because I *only return two-thirds of the steam* to the boiler; whereas, so far as he deals with the question, I might as well return *water*, because he objects to and argues against a result which is in excess of what an *ideal engine* with a *water* feed can do; so that whilst he ignores the benefit of a *steam* feed he really proves its value.

This gentleman has given us figures and calculations for our consideration which I have dealt with above, so far as they apply to the question. I will now submit in a practical manner what a *steam feed* really means.

Take 10 lbs. of water as the best ordinary practice evaporation from 1 lb. of coal.

Take 2 lbs. of coal as the best ordinary practice consumption per H.P. per hour. From the above we get 20 lbs. of steam consumption per 1 H.P. per hour.

And 20 lbs. of steam at 100 lbs. pressure contain 24,230 units of heat, which, multiplied by "Joule's equivalent" of 772 foot-pounds per heat unit, and divided by the 33,000 × 60′ which is assumed as the H.P. unit, gives us 9·44 H.P., or, approximately, that 10 H.P. which is frequently spoken of as the result that would replace our existing 1 H.P., could perfect caloric action be accomplished.

The return of all the latent heat cannot be accomplished, because water is a necessity to the operation; but two-thirds of the steam has been already returned, and such result has been effected by means of an air spring, and with less *loss* of power than a water feed requires. Such effected two-thirds of 9·44 therefore leaves a necessary 6 to 1 result.

In regard to what Mr. A. Reckenzaun writes, you will observe that the brake used was carefully examined by Mr. Margary before he used it, as subsequently by Mr. Howard before he used it, and it would not appear desirable that I should further discuss a side issue which does not affect the fact that by the process I exhibit I return two-thirds of the steam with the *latent heat* in it to the boiler.

In the meantime I shall urge matters forward to the purpose of a further and more perfect exhibition with a generally-approved brake.

R. M. Marchant.

October 25th, 1886.

The perusal of Mr. Marchant's reply to my questions has given me much disappointment. These questions, I considered, were sufficiently plain and straightforward not to be easily misconstrued, and in their application could only relate to his own engine, which, if I am not misinformed, is the identical engine that was tried at the Inventions Exhibition last year. I expected a clear

and definite answer to each of my enquiries that would help to elucidate some of the anomalies connected with your tests. In its place, however, I find a lengthy comment which passes over No. 1 and 2, declares No. 3 to be wrong in the dimensions (these were given to me by a gentleman who obtained them from Mr. Marchant himself during a trial some months back), sets down No. 4 as an erroneous assumption (the said assumption being derived from and supported by the indicator diagrams taken at the exhibition), and consequently No. 5, based on it, cannot be taken as a follower, and is answered by Nos. 1 and 2; while to my last query as to the effect of screwing up the nut, n', I get a dissertation on the position of the brake lever.

However unintentional it may be, the result of all this means the evasion of a direct reply to my two last important questions, and a substitution of many and much italicised remarks, of which the following are samples:—Twister can scarcely be an engineer, &c., another, that non-expansive engines in Birmingham consumed more than 10 lbs. of coal per horse-power hour. I will say nothing as to the relevancy of these statements and will leave others to connect them and thence deduce an intelligible answer to question 5 which runs, "Can the calculated horse-power in this case be made to equal the brake horse-power as shown by your tables."

To critise Mr. Marchant's comments on my letter would be to very little purpose, besides occupying uselessly your valuable space, and would probably lead to a long controversy into which I am not disposed to enter. It is also quite unnecessary to request more explicit answers, your other correspondents having furnished most direct and pertinent replies which fully endorse the inferences to be drawn from my questions.

If Mr. Marchant were to run his engine with a powerful dynamo, I think he would discover, and have to admit that his brake does not at all times give a true expression of power.

Twister.

October 26th, 1886.

[We ourselves consider that a run with a dynamo would settle the matter once and for all within very trifling limits of error.—EDS. ELEC. REV.]

The Threatened Monopoly in Lamps.

Having been present at the meeting held on the 14th inst. at the Cannon Street Hotel, I desire, through your influential paper, to offer a few remarks on this important question, premising that I attended the meeting to learn and not to express opinions. I will say at once that I was very much struck by the calm and clear remarks of Mr. Rawson, and I think that, though not impassioned, his address was full of facts and sound common sense. I hope that the measures adopted at the meeting will tend to ensure uniformity of action for the common good, for if there is not a hearty and unselfish response to his appeal, and the common danger is not recognised by all to be so great as to demand hearty co-operation instead of each playing his own game, *all* will find when too late that they have lost their individual games and are all at the mercy of ruinous monopoly.

Messrs. Woodhouse & Rawson in fighting their own battle are practically the champions of the whole trade and of all who are interested in electric lighting, and it is perfectly justifiable that they should ask all such to share the cost of the appeal. But I would go further than this, for I feel that, whatever the result of the appeal, a subscription ought to be started to reimburse Messrs. W. & R. the whole of the expenses of the *two* trials, and my firm will willingly contribute their mite to such a fund. Is it premature to ask you, Sirs, to put this suggestion into practical form, and say whether you would consent to "father" such a fund at the proper time?

If I were to set myself to define who are the interested ones, I should simplify my task by trying to find someone who is not. In my search for such I should fail, for when a good lamp is to be bought cheap, there will doubtless be an enormously extended demand for electric lighting, and this increase will affect the makers of dynamos, engines, cables, fittings, and a large body of cultivated workmen, as well as the large number of educated men who have entered this branch of engineering, much more than it will the lampmakers, who are very few in proportion to the other interests named.

The public, too, who want the light more and more, are more deeply interested than they think, for all the achievements and progress made in all other branches tending to bring incandescent lighting within their reach will be nullified by a prohibitory price asked for lamps by the monopolists (or even an entire refusal to sell), and the light will be further from their reach than ever.

I am no advocate for abolishing patents, for I am sure that they, by securing a reward for labours, stimulate useful invention to the good of all. Such monopolies, established by law, must be respected, but their scope must be clearly defined, and confined within the provisions as to novelty, which the law creating them imposes as a condition of their being granted.

The Edison & Swan Company are perfectly welcome to any valid patent they hold for any specific methods of preparing filaments, and if their lamps, so constructed, are better than others, their reward is sure; but if not, it is not right that their claims should be so enlarged as to include all other methods, or the use of all high resistance filaments in a vacuum, which extended claim, if upheld, will effectually bar the way to all improvement. It is a singular fact, as mentioned by Mr. Swinburne, that the great and undoubted improvements (and therefore valid subjects for patents) made in lamps in recent years are the result of the labours of others, and these patents, where they exist, can only become a source of profit to these inventors if the threatened monopoly is upset.

What, therefore, is wanted is that all should recognise that if this decision is adverse, nearly all their occupations will be gone.

Apologising for the length of this letter, I will sign myself one who fully appreciates that he is

Interested.

P.S.—Since drafting the above on the day after the meeting, the article in your last issue has appeared, which rather anticipates the drift of my remarks on many points, and it is needless for me to say that I cordially agree with your remarks throughout that leader, and feel what an advantage it is to the trade to possess such a Journal.

I have said that I should fail to find anyone who is not interested in the monopoly being upset, and some may think that I have forgotten the monopolists. I do not even except them, for electric lighting has not yet reached a state when the public *will* have it, regardless of cost, so that, if they raise the price of lamps, they won't get business, and even if they reduce the price to users of their system they would have to maintain such extended branches to do all the work, that when their monopoly ceased to exist, they would be killed by their own greatness when competition attacked them. With an open market now, if their lamp is reasonably good, they will secure quite as large a share of public patronage as any other firm.

There will be room for all other good makers, and the freedom secured to the trade generally will lead to enterprise, with a consequent great increase of business all round. The security of a monopoly may become, by neglect of its possibilities or by a too grasping policy, the cause of failure to secure an adequate reward, aud may so defeat its own end, especially when it is in the hands of irreponsible capital. The trade has already the existing gas monopolies to fight, which are quite as much as it is equal to without its own votaries creating a new monster to be slain.